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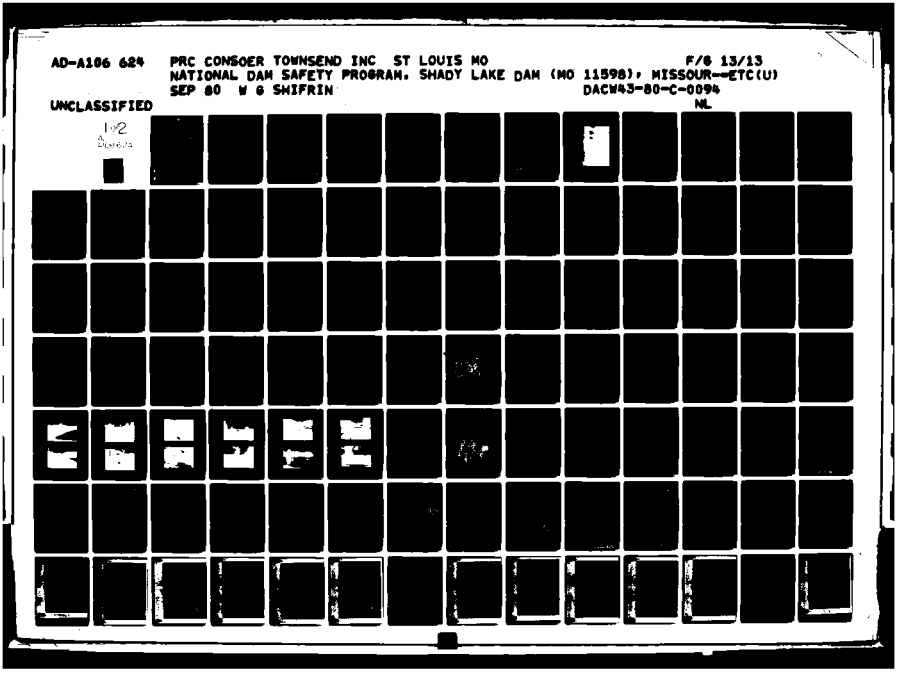

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SHADY LAKE DAM
BOONE COUNTY, MISSOURI
MO. 11598

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

Cont'd

SUBJECT: Shady Lake Dam (Mo. 11598) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Shady Lake Dam (Mo. 11598).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood;
2) Overtopping could result in dam failure; and
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 02 OCT 1980 — Date

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 06 OCT 1980 — Date

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SHADY LAKE DAM
BOONE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 11598

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

SEPTEMBER 1980

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Shady Lake Dam, Missouri Inv. No. 11598
State Located: Missouri
County Located: Boone
Stream: An unnamed tributary of Bear Creek
Date of Inspection: June 2, 1980

Assessment of General Condition

Shady Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and PRC Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri according to the U. S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property damage could occur in the event of failure of the dam. Within the estimated damage zone of one mile downstream of the dam are five dwellings, a trailer, several warehouses and commercial buildings, a U.S. highway crossing and a quarry all of which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Shady Lake Dam is in the small size classification since it is less than 40 feet in height and impounds less than 1,000 acre-feet of water.

Our inspection and evaluation indicate that the reservoir/spillway system of Shady Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Shady Lake Dam being a small size dam with a high hazard

potential is required by the guidelines to be able to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping the dam. Considering the number of inhabited dwellings and places of business located downstream of the dam, the PMF is considered the appropriate spillway design flood for Shady Lake Dam. It was determined that the reservoir/spillway system can accommodate approximately 20 percent of the Probable Maximum Flood before overtopping of the dam occurs. Our evaluation also indicates that the reservoir/spillway system will not accommodate the one-percent chance flood (100-year flood) without overtopping.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Shady Lake Dam and its appurtenant structures are in satisfactory condition. Nevertheless, some deficiencies were noted by the inspection team, which could affect the safety of the dam and appurtenant structures. These items are as follows: the minor wave erosion on the upstream slope; rodent activity on the embankment; the bushes growing on the embankment above the service spillway outlet; the accumulation of debris on top of the trashrack of the service spillway; the unmaintained grass cover in the emergency spillway; a need for periodic inspection by a qualified engineer and a lack of a maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take immediate action to correct or control the several deficiencies described above in the near future.

Walter G. Shifrin, P.E.

Overview of Shady Lake Dam

NATIONAL DAM SAFETY PROGRAM

SHADY LAKE DAM, I.D. No. 11598

TABLE OF CONTENTS

Sect. No.	Title	Page
SECTION 1	PROJECT INFORMATION	1
	1.1 General	1
	1.2 Description of Project	2
	1.3 Pertinent Data	7
SECTION 2	ENGINEERING DATA	10
	2.1 Design	10
	2.2 Construction	10
	2.3 Operation	10
	2.4 Evaluation	10
SECTION 3	VISUAL INSPECTION	12
	3.1 Findings	12
	3.2 Evaluation	18

TABLE OF CONTENTS

(Continued)

Sect. No.	Title	Page
SECTION 4	OPERATION PROCEDURES	20
	4.1 Procedures	20
	4.2 Maintenance of Dam	20
	4.3 Maintenance of Operating Facilities	20
	4.4 Description of Any Warning System in Effect	21
	4.5 Evaluation	21
SECTION 5	HYDRAULIC/HYDROLOGIC	22
	5.1 Evaluation of Features	22
SECTION 6	STRUCTURAL STABILITY.	26
	6.1 Evaluation of Structural Stability.	26
SECTION 7	ASSESSMENT/REMEDIAL MEASURES. . . .	28
	7.1 Dam Assessment	28
	7.2 Remedial Measures.	30

TABLE OF CONTENTS

(Continued)

LIST OF PLATES

	Plate No.
LOCATION MAP	1
PLAN AND ELEVATION OF DAM	2
EMBANKMENT SECTION AND SPILLWAY PROFILE	3
GEOLOGIC MAP	4-5
SEISMIC ZONE MAP	6

APPENDICES

APPENDIX A - PHOTOGRAPHS

APPENDIX B - HYDROLOGIC AND HYDRAULIC COMPUTATIONS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

SHADY LAKE DAM, Missouri Inv. No. 11598

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Shady Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and PRC Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Shady Lake Dam was made on June 2, 1980. The purpose of the inspection was to make a general assessment regarding the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, provides a summary of visual observations made during the field inspection, gives an assessment of hydrologic and hydraulic conditions at the site, presents an evaluation of the

structural adequacy of the various project features and appraises the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report, reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the southwest abutment or side, and right to the northeast abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and conversations with Mr. Ron Shy, the owner's representative. No design drawings for the dam or appurtenant structures were available.

The dam is a homogeneous, rolled earthfill structure with a straight alignment between earth abutments. Photos 1 through 3 and photo 9 show views of the embankment. The top of dam is 15 feet wide and 365 feet long, and it varies in elevation. From the emergency spillway, the top of dam has an upward slope to a point

250 feet to the left of the emergency spillway, gaining 1.25 feet in elevation; the final 115 feet along the axis has another upward slope, gaining an additional 5.5 feet in elevation. This makes the left abutment/embankment contact 6.75 feet higher in elevation than the top of dam elevation adjacent to the emergency spillway (see Plate 2). The minimum elevation is assumed to be approximately 714 feet above mean sea level (M.S.L.). The maximum structural height of the dam was measured to be 26 feet. The upstream and downstream slopes were measured to be 1 vertical to 3 horizontal (1V to 3H). (The upstream slope was measured from the top of dam to the water surface only.) A small berm on the upstream slope was observed around the service spillway. According to Mr. Shy, a 12-foot wide core trench was excavated parallel to the embankment and into bedrock.

A two spillway system is utilized at this damsite and consists of a service spillway, functioning with a drop inlet, and an emergency spillway, functioning with an open channel (see Photo Overview).

The inlet to the service spillway is situated approximately 115 feet to the right of the left abutment and about 5.5 feet lower in elevation than the top of dam at that point. The standpipe portion of the inlet is constructed of a 54-inch diameter corrugated metal pipe which has a vertical drop of 16 feet, according to Mr. Shy; also, the top of the standpipe has a concrete collar with attached trashrack. There is a 42-inch corrugated metal pipe which carries the flow on a 3.0 to 3.5 percent slope from the bottom of the standpipe to the outlet end of the pipe, where the water drops 2 feet onto the bedrock of the downstream channel (see Photo 5). Also, according to Mr. Shy, there are two or three concrete seep collars along the pipe and founded on in situ material. The alignment of the spillway pipe crosses the dam axis on a 25° left skew from normal (see Plate 2).

The emergency spillway has a trapezoidally shaped control section located on the right side of the dam; it has a top width of 51 feet and a bottom width of 27 feet with side slopes of approximately 1V to 10H. The discharge channel is more or less perpendicular to the dam and slopes approximately 4 percent from the crest of the spillway for 61 feet until it intersects a 2 percent slope (see Plate 3). The emergency spillway crest is 1.25 feet lower than the adjacent top of dam and 3 feet higher than the service spillway crest. It would appear that water flowing over the spillway crest and into the discharge channel would move in sheet flow fashion. A training berm on the left side of the discharge channel guides flows through the spillway and away from the dam (see Photo 9).

According to Mr. Shy a low level outlet was provided for the dam. The outlet consists of a 6-inch gate valve located in the bottom of the drop inlet structure of the service spillway. A 6-inch pipe passes through the wall of the drop inlet structure and into the reservoir. The outlet discharges into the service spillway pipe. The outlet is, reportedly, capable of lowering the reservoir level approximately 16 feet below the crest of the service spillway.

b. Location

Shady Lake Dam is located in Boone County of the State of Missouri on an unnamed tributary of Bear Creek. The dam is located approximately 1/2 mile north of the city limits of Columbia less than 1/2 mile east of U.S. Highway 63, in the north central portion of Section 6 of Range 12 West, Township 48 North as shown on the Columbia, Missouri Quadrangle (7.5 minute series) Sheet.

c. Size Classification

The Shady Lake Dam reservoir has an impoundment less than 1,000 acre-feet and greater than 50 acre-feet which classifies it as a "small" size dam. The Shady Lake Dam has a maximum structural height less than 40 feet and greater than 25 feet, which also classifies it as a "small" size dam. Therefore, the size classification is determined to fall within the "small" category, according to the "Engineer Regulation No. 1110-2-106", Appendix D, by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. From a visual inspection of the downstream area, our findings concur with this classification. There are five dwellings, a trailer, several warehouses and commercial buildings, a U.S. highway crossing and a quarry within the estimated damage zone, which extends approximately one mile downstream of the dam (see Photos 11 and 12).

e. Ownership

Shady Lake Dam is privately owned by Mrs. Dorothy M. Clary. The mailing address is as follows: Mrs. Dorothy M. Clary, 1501 Vandiver Drive, Columbia, Missouri, 65201.

f. Purpose of Dam

Shady Lake Dam was constructed to impound water for use as a recreational lake. At this time, the reservoir is fenced off from the trailer court which partially surrounds it.

g. Design and Construction History

According to Mr. Ron Shy, the dam was built in 1968 by Mr. Vic Clary, a private contractor and the original owner. Mr. Clary has since passed away and no records concerning design notes or construction methods were available for use in this report.

Mr. Shy also informed the inspection team that to the best of his knowledge the Soil Conservation Service, located in Columbia, Missouri, designed Shady Lake Dam. According to Mr. Ken McManus, State Conservationist, the Soil Conservation Service has no information in its files for Shady Lake Dam.

h. Normal Operational Procedures

Normal procedure is to allow the lake to remain as full as possible while the water level is controlled by rainfall, runoff, evaporation, and the elevation of the service spillway crest.

1.3 Pertinent Data

a. Drainage Area (square miles):. 0.33

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): . . . . . 276 (Less than)

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 276

c. Elevation (Feet above M.S.L.)

Top of dam (minimum):. . . . . 714 (Assumed)

Spillway crest:

Service Spillway 709.75

Emergency Spillway 712.75

Normal Pool: 709.75

Maximum Experienced Pool:. . . . . 714 (Less than)

Observed Pool: 709.75

d. Reservoir

Length of pool with water surface at top of dam elevation (feet):. 1000

e. Storage (Acre-Feet)

Top of dam (minimum):. 60

Spillway crest:

Service Spillway 29

Emergency Spillway 49

Normal Pool: 49

Maximum Experienced Pool:. . . . . 60 (Less than)

Observed Pool: 29

f. Reservoir Surfaces (Acres)

Top of dam (minimum):. 9.5

Spillway crest:

Service Spillway 4.5

Emergency Spillway . . .	8
Normal Pool:	4.5
Maximum Experienced Pool:.	9.5 (Less than)
Observed Pool:	4.5

g. Dam

Type:.	Rolled, Earthfill
Length:.	365 feet
Structural Height:	26 feet
Hydraulic Height:.	26 feet
Top width:	15 feet
Side slopes:	
Downstream	1V to 3H
Upstream	1V to 3H (Above the water surface)
Zoning:.	Homogeneous
Impervious core:	NA
Cutoff:.	A core trench with a 12-foot bottom width excavated to bedrock, according to Mr. Shy.
Grout curtain:	No
Freeboard above normal reservoir level:	4.25 feet (minimum)
Volume:.	18,000 cu.yds. (estimated)

h. Diversion and Regulating Tunnel None

i. Spillway

Type:	
Service Spillway	Drop inlet, uncontrolled
Emergency Spillway	Earthcut channel, uncontrolled
Length of crest:	
Service Spillway	14 feet, approximately (54-inch diameter standpipe)
Emergency Spillway	27 feet
Crest Elevation (feet above MSL):	

Service Spillway	709.75
Emergency Spillway	712.75

j. Regulating Outlets

Type	6-inch diameter low level outlet
Location	Gate valve located in the bottom of the drop inlet structure of the service spillway.
Length	Unknown
Closure	6-inch diameter gate valve
Maximum Capacity	Unknown, capable of lowering the normal water surface 16 feet.

SECTION 2: ENGINEERING DATA

2.1 Design

No design drawings, specifications, or "As-built" drawings were available for Shady Lake Dam. It is not known whether the dam was designed by a qualified engineer.

2.2 Construction

No data are available concerning the construction of the dam and appurtenant structures. The following information concerning the construction of the dam and appurtenant structures was obtained from conversations with Mr. Shy. The compaction of the embankment was achieved by the activity of the earthmoving equipment used to construct the embankment. No compaction tests were performed. The core trench was excavated to sound bedrock. The pipe for the service spillway which passes through the embankment is not founded on bedrock.

2.3 Operation

No records of operation are available for Shady Lake Dam.

2.4 Evaluation

a. Availability

The availability of engineering data is poor and consists only of a Soil Survey for Boone County published by the Soil Conservation Service, State Geological Maps, and U.S.G.S. Quadrangle sheets.

b. Adequacy

The available engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection, past performance and present condition of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data are available except that mentioned in paragraph 2.4a.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Shady Lake Dam was made on June 2, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Project Engineer, Soils and Mechanical
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
Ken Bullard, P.E.	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
Robert McLaughlin, P.E.	PRC Engineering Consultants, Inc.	Civil
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Ron Shy, P.E.	Owner's Representative	

Specific observations are discussed below.

b. Dam

The overall condition of the dam appeared to be satisfactory. However, some items of concern were observed and are described below.

The top of dam is protected from erosion by an adequate grass cover (see Photo 2). The top of dam is occasionally used as an access road and consequently, tire tracks were observed. No tire ruts or depressions which are sometimes associated with vehicular traffic across earthen structures were observed. The 5.5 foot change in elevation of the top of dam near the left abutment was constructed in this way to gain access to the dam from the left abutment area (see Photo 3). The small variation in elevation of the remaining portion of the top of dam did not appear to be due to an instability of the embankment. No depressions indicating a settlement of the embankment were observed. No significant deviation in horizontal alignment was apparent. No cracks were observed on the top of dam. According to Mr. Shy, the dam has never been overtopped and no evidence indicating the contrary was observed.

The upstream slope has no riprap protection. Consequently, some minor erosion has occurred due to wave action. The slope above the water surface was adequately protected against surface runoff by a good grass cover (see Photo 1). No bulges, depressions or cracks indicative of an instability of the slope were observed. No erosional problems due to surface runoff on the upper portion of the slope were observed. Small animal burrows measuring approximately 1 inch in diameter were observed.

The downstream slope is adequately protected against surface runoff by a good, unmaintained grass cover. No bulges, depressions or cracks indicative of an instability of the slope were apparent. A comprehensive inspection of the slope was hampered by the tall growth of grass on the slope. No seepage was observed on the embankment or downstream of the toe. Small animal burrows

measuring approximately 1 inch in diameter were observed. No trees were observed growing on the embankment, however, a thick growth of bushes was observed on the downstream slope just above the outlet of the service spillway.

The right abutment slopes gently upward from the top of dam and at the left abutment, there is a sharp difference in elevation between the top of dam and the abutment. The area behind the left abutment supports a mobile home park. No instabilities or seepage areas were observed on either abutment.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of Bear Creek in the Dissected Till Plains Section of the central Lowland Physiographic Province. Loess-mantled Kansas drift covers the surface of most of the Dissected Till Plains Section. This section is distinguished from the Young Drift Section to the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain submature to mature in its erosion cycle.

The topography at the damsite is rolling with U to V-shaped valleys; elevation ranges from 700 feet above M.S.L. at the damsite to 750 feet above M.S.L. one mile northeast of the site. The reservoir slopes are generally between 15° to 30° from horizontal at the southern side of the reservoir, and 10° to 13° from horizontal at the northern side. The area near the damsite is covered with slope wash deposits of glacial-fluvial and loess origins consisting of reddish brown, clayey silt, and some fine to medium sand.

The regional bedrock geology beneath the glacial outwash deposits in the damsite area, shown on the Geologic Map of Missouri (1979) (see Plate 4), consists of Pennsylvanian age rocks of the Marmaton-Cherokee Group (cyclic deposits of shale, limestone and sandstones), Mississippian age Burlington Limestone (cherty, grayish brown, sandy, limestone), Devonian age rocks (Bushberg Sandstone, Glen Park Limestone, Grassy Creek Shale) and Ordovician age rocks consisting of St. Peter Sandstone and Powell Dolomite. The predominent bedrock near the damsite, underlying the glacial-fluvial deposits, consists of the Cherokee Group rocks and Burlington Limestone.

Inlet and outlet areas of the unnamed tributary of Bear Creek exhibit Quaternary alluvium. Outcrops of the Pennsylvanian Marmaton Group of rocks consisting of moderately weathered to unweathered, grayish brown to white, fine to medium grained, hard limestone, horizontally interbedded with dark gray hard shale are exposed at the downstream channel near the spillway outlet and at the southern rim of the reservoir.

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Fox Hollow Fault nearly 15 miles south of the damsite. The Fox Hollow Fault had its last movement in post-Mississippian time. Thus, the fault has no effect on the dam.

Shady Lake Dam consists of a homogeneous earthfill embankment, a drop inlet service spillway with a metal outlet pipe located at the mid-third section of the embankment, and an emergency spillway located at the right abutment end of the embankment.

No boring logs or construction reports were available which would indicate foundation conditions encountered during the construction. Based on the visual inspection and conversations with Mr. Ron Shy, the embankment rests on the Pennsylvanian-Marmaton Group bedrock (limestone) with a core trench excavated into the

bedrock. The drop inlet service spillway and metallic outlet pipe of the service spillway rests on the compacted embankment material, according to Mr. Shy. The emergency spillway is cut into the compacted embankment fill.

(2) Project Soils

According to the "Soil Survey for Boone County Missouri" published by the Soil Conservation Service in 1962, the common soils in the general area of the dam belong to the Prairie-Timber Transition: Gara association. From the Boone County soil maps, the soils at the damsite consist of the Union silt loam and silty clay loam, the Gara loam, and the Sharon silt loam soil types. These soils are basically formed from glacial till, alluvium and weathered limestone. The Gara loam may be susceptible to erosion. If the Gara loam was used in the embankment, the potential of failure of the embankment would be increased due to erosion during overtopping.

Materials removed from the upstream and downstream slopes of the embankment ranged from a dark, reddish brown, fine, sandy silt to a medium brown, clayey silt with traces of fine to medium sand. Based upon the Unified Soil Classification System, both soils would probably be classified as an ML. This soil type generally has the following characteristics: an impervious soil with a coefficient of permeability less than 50 feet per year, medium to low shear strength, and intermediate to low resistance to piping.

d. Appurtenant Structures

(1) Service Spillway

The service spillway inlet was severely obstructed with brush and garbage covering the trashrack (see Photo 4). Although the concrete collar and trashrack were not visible on the day of the inspection, it was noticed that the trashrack itself was set across the inlet in loose fashion. However, it appeared that the service

spillway standpipe and discharge pipe were stable, and no leakage was discerned around or in the vicinity of the outlet end of the spillway. According to the owner's representative, the trashrack had been replaced in the past on more than one occasion and he wants to replace it with a better one in the near future.

(2) Emergency Spillway

The emergency spillway approach has a 10 percent slope which is integral with the upstream slope of the dam. The spillway and discharge channel are covered with fescue grass that is 2 to 3 feet high (see Photos 7 and 8). The owner's representative believes that the water from the reservoir has flowed over the emergency spillway four or five times that he remembers. The discharges through the spillway did not appear to have caused any damage to the crest or discharge channel of the spillway. It appears that the excess flows would enter the discharge channel and then overflow the banks into an open field before eventually reaching the downstream channel.

(3) Outlet Works

The 6-inch low level drain was inaccessible on the day of the inspection due to its location in the drop inlet structure and to the trash and debris covering the entrance to the drop inlet. According to Mr. Shy, the valve has only been operated once in the past. It was used to lower the reservoir so that a deposit of silt could be removed from the upper end of the reservoir. The valve has not been operated recently. The valve can be operated from the top of the drop inlet structure by a removable valve wrench. The whereabouts of the valve wrench on the day of the inspection was unknown, but the valve can also be operated by a hand wrench.

e. Reservoir Area

The reservoir water surface elevation at the time of inspection was 709.75 feet above M.S.L.

The surface area of the reservoir at normal water level is about 4.5 acres. A mobile home park is located in close proximity to the reservoir (see Photo 10). The rim appeared to be stable. One large erosional gully was observed upstream of the embankment on the left side of the reservoir. The gully appeared to be formed from surface runoff from the mobile home park and it has no effect on the embankment. No other erosion or instabilities were observed on the reservoir rim which would be detrimental to the stability of the embankment.

f. Downstream Channel

The downstream channel is well defined. The channel has a bottom width of about 11 feet and has side slopes of approximately 1V to 0.5H. The channel is approximately 3 feet deep. The channel is obstructed near the damsite with trees and trash (see Photo 6). The floodplain outside of the channel is fairly wide near the damsite and is grass and tree covered.

3.2 Evaluation

The visual inspection uncovered nothing of a consequential nature which would require immediate remedial action. However, some conditions were observed which could adversely affect the dam in the future and these should be corrected within a reasonable period of time.

1. The small animal activity observed on the upstream and downstream slopes could jeopardize the safety of the dam. The holes created by the small animals make avenues for possible piping.

2. The minor wave erosion on the upstream slope does not appear to affect the stability of the dam in its present condition. The condition is not serious enough at this time to warrant repairs but it should be monitored.

3. The bushes observed on the slope just above the service spillway outlet and the unmaintained grass cover on the embankment are not detrimental to the dam. A tall vegetative growth on the embankment could prevent a comprehensive inspection of the embankment and potential problems could go undetected.

4. Although the service spillway was operating quite adequately for the flows observed on the day of the inspection, it is felt that problems would arise during severe floods due to the obstructing effect of the brush, trash, etc. covering the service spillway inlet; floodwaters would hasten the arrival of additional brush, trash, etc. at the inlet from around the reservoir, causing additional flow retardance and contributing to any potential overtopping of the dam. The trashrack seemed fairly loose and somewhat weak on the day of inspection; if it were to collapse due to the pressures resulting from flooding, much trash and general bulk would be forced into the standpipe, thus possibly choking some of the entryway to the spillway conduit. This reduced capacity would contribute to use of the emergency spillway and possible overtopping of the dam. The emergency spillway has a high stand of grass within its crest and discharge channel which could also contribute to flow retardation and reduced conveyance. The combination of obstructed service and emergency spillways contributes to a lessening of the ability of the dam to handle even the smaller flood flows.

5. Even though the gate valve for the low level drain is reportedly operable, the valve should be periodically operated and kept in working condition. The misplaced valve wrench should be relocated and kept in an accessible place.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Shady Lake Dam was built for recreational purposes, and there are no specific procedures which are followed for the operation of the dam or reservoir. The water level is controlled by rainfall, runoff, evaporation, and the elevation of the service spillway crest.

4.2 Maintenance of Dam

The dam and appurtenant structures are maintained by workmen employed by the owner, Mrs. Clary. The owner's representative, Mr. Ron Shy, informed the inspection team that they had a problem with rodents in the embankment several years ago but that lately the problem has been brought under control. Mr. Shy also mentioned that the slopes are mowed periodically. There are no trees growing on the slopes at this time. It appears that minor wave erosion is deteriorating the upstream slope due to inadequate riprap. The trashrack of the service spillway was covered with debris.

4.3 Maintenance of Operating Facilities

The only facility at the damsite which requires periodic maintenance is the low level outlet valve, located at the base of the drop inlet. The low level outlet could not be reached for examination on the day of the inspection due to its location and condition of the service spillway inlet trashrack. According to Mr. Ron Shy, the 6-inch low level valve is operable.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system consisting of any electrical warning system or manual warning notification plans for this dam.

4.5 Evaluation

Operational procedures are non-existent, and the maintenance seems to be fair. The remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

5.1 Evaluation of Features

a. Design

The watershed area of the Shady Lake Dam upstream from the dam axis consists of approximately 211 acres. The watershed area is mostly grass covered with some wooded areas and urban development. Land gradients in the watershed average roughly 2.5 percent. The Shady Lake Dam Reservoir is located on an unnamed tributary of Bear Creek. The reservoir is about 0.5 miles upstream from the confluence of the unnamed tributary and Bear Creek. The watershed measures approximately 0.8 miles at its longest arm. A drainage map showing the watershed and the downstream hazard zone is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of Shady Lake Dam was based upon criteria set forth in the Corps of Engineers' "Engineer Regulation No. 1110-2-106" and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based upon criteria given in the Corps of Engineers' EM 1110-2-1411 (Standard Project Storm). The Soil Conservation Service (SCS) method was used for deriving the unit hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). The unit hydrograph parameters are presented in Appendix B. The SCS method also was used for determining the loss rate. The hydrologic soil group of the watershed was determined by use of published soil maps. The hydrologic soil

group of the watershed and the SCS curve number are presented in Appendix B. The curve number, unit hydrograph parameters, the PMP index rainfall and the percentages for various durations were the direct input to the HEC-1 (Dam Safety Version) computer program used to obtain the PMF hydrograph. The computed peak inflows of the PMF and one-half of the PMF are 4,163 cfs and 2,082 cfs, respectively.

Both the PMF and the one-half PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method also utilizing the HEC-1 (Dam Safety Version) computer program. A storm of 50 percent of the PMF preceded the PMF and a storm of 25 percent of the PMF preceded the one-half PMF, each by 4 days. The reservoir was assumed at the mean annual high water level at the begining of the antecedent storm. The mean annual high water level for Shady Lake was estimated to be at the crest of the service spillway. The antecedent storm of 50 percent of the PMF, when routed through the reservoir, will leave the reservoir at approximately the same elevation as the crest of the service spillway at the end of the four day period. Thus, the reservoir was assumed at the crest level of the service spillway at the start of the routing computation for the PMF, the one-half PMF and other PMF ratio floods. The peak outflow discharges for the PMF and the one-half PMF are 3,774 and 1,778 cfs, respectively. Both the PMF and the one-half PMF when routed through the reservoir resulted in overtopping of the dam.

The sizes of physical features, utilized to develop the stage-outflow relation for the spillway and overtopping of the dam, were taken from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were obtained from the U.S.G.S. Columbia, Missouri Quadrangle topographic map (7.5 minute series). The reservoir elevation-area curve and the spillway and overtop rating curve are presented as Plates 2 and 3, respectively, in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erodable characteristics. The safe hydrologic design of an embankment dam requires a spillway discharge capability combined with an embankment height that can handle a very large and exceedingly rare flood without overtopping the dam.

The Corps of Engineers designs dams to safely pass the Probable Maximum Flood that could be generated from the dam's watershed. This is the generally accepted criterion for major dams throughout the world and is the standard for dam safety where overtopping would pose any threat to human life. Accordingly, the hydrologic requirement for safety for this dam is the capability to pass the Probable Maximum Flood without overtopping the dam.

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site. However, according to the owner's representative, the maximum reservoir level was about equal to the minimum top of dam on four or five occasions since 1967, but the dam was never overtopped. No evidence indicating the contrary was observed.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 5.1.a, both the Probable Maximum Flood and one-half of the Probable Maximum Flood when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF and the one-half PMF are 3,774 and 1,778 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 276 cfs. The PMF overtopped the dam by 2.79 feet and the one-half PMF overtopped the dam by 1.76 feet. The total duration of overflow over the lowest point on the top of dam is 6.0 hours during the PMF and 4.0 hours during the occurrence of the one-half PMF. The spillway/reservoir system of Shady Lake Dam is capable of accommodating a flood equal to approximately 20 percent of the PMF just before overtopping the dam. The reservoir/spillway system of Shady Lake Dam will not accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately one mile downstream of the dam. There are five dwellings, a trailer, several warehouses and commercial buildings, a U.S. highway crossing and a quarry within the damage zone.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The minor wave erosion on the upstream slope does not appear to endanger the structural stability of the embankment in its present condition. Nevertheless, continual erosion could be detrimental to the embankment. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The combination of the potential blockage of the service spillway and the retardation of flow in the emergency spillway due to the high stand of grass could contribute to a problem of instability in the situation wherein overtopping of the dam occurs.

b. Design and Construction Data

No design computations pertaining to the embankment were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. The water level on the day of inspection was at the crest of the service spillway, and the reservoir, reportedly, remains close to full at all times. The low level drain is reportedly operable.

d. Post Construction Changes

No post construction changes to the embankment are known to exist which will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1 (see Plate 6), as defined in "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude which would be expected in Seismic Zone 1 will not cause significant distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of the inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Shady Lake Dam is found to be "Seriously Inadequate". The spillway/reservoir system will accommodate about 20 percent of the PMF without overtopping the dam. The safety of the embankment will be in jeopardy if the dam is overtopped. The dam itself would be susceptible to erosion due to the high velocity of flow on its downstream slope which could lead to an eventual failure of the dam.

The dam and appurtenant structures appeared to be in satisfactory condition. However, a quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment and appurtenant structures, however, have reportedly performed satisfactorily since their construction without failure or evidence of instability. The dam has never been overtopped according to Mr. Shy and no evidence indicating the contrary was observed. The safety of the dam can be improved if the deficiencies described in Section 3.2 and 6.1a and below are properly corrected and the dam properly maintained as described in Section 7.2b. The existence of burrowing animals on the embankment could jeopardize the safety of the dam.

b. Adequacy of Information

Pertinent information relating to the design of the dam and appurtenant structures is completely lacking. The conclusions presented in this report are based on field measurements, past performance and the present condition of the dam. Information on the design hydrology, hydraulic design, and the operation and maintenance of the dam, as well as seepage and stability analyses were not available for review. Lack of seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" is considered a deficiency.

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and assuming that the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase the spillway capacity to pass the PMF, without overtopping the dam.

2. Increase the height of the dam in order to pass the PMF without overtopping the dam; an investigation should also include studying the effects on the structural stability of the present embankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. Determine the extent of damage done to the embankment by burrowing animals, if any, and make corrective repairs as required.

2. The minor wave erosion on the upstream slope should be monitored, and, if the erosion continues, protective measures should be employed to preserve the slope from further damage.

3. The bushes observed on the slope just above the service spillway outlet should be removed from the slope and their regrowth prevented. The grass cover on the embankment should be periodically cut and maintained at a maximum height, e.g. 1 foot. Large vegetation, such as bushes and trees, should be prevented from growing on the embankment.

4. The service spillway is presently (on the day of the inspection) covered with debris and has a very loose trashrack system. All of the brush, trash, etc. should be cleared away from the service spillway inlet and an unobstructed passageway should be maintained. The trashrack, though unobserved due to its burial under the debris, was assumed to be in adequate condition. A new trashrack may be needed or the existing one may be satisfactory; in either case, it should be secured so that it cannot break loose from its position over the inlet and it should be strong enough to withstand any potential imposed pressure.

5. **The emergency spillway crest and discharge channel are covered with a 2 to 3 foot high growth of fescue grass in most areas. This grass should be properly cut and maintained at a maximum height, e.g., 1 foot.**

6. **The gate valve for the low level outlet should be properly maintained, as recommended by the valve manufacturer, and operated periodically to be sure it is in working order. The misplaced valve wrench should be relocated and the wrench kept in an accessible place.**

7. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

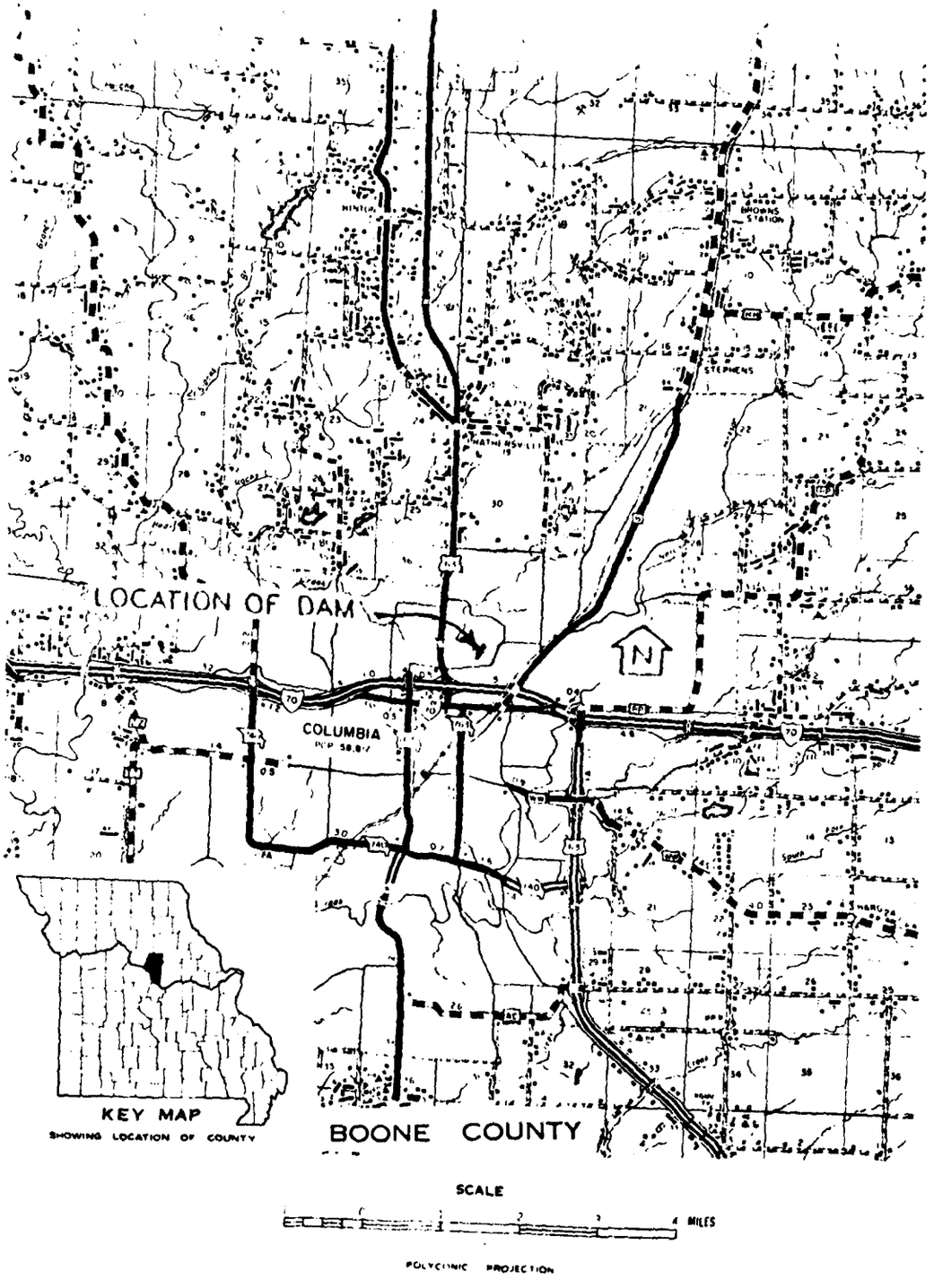
8. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

   (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

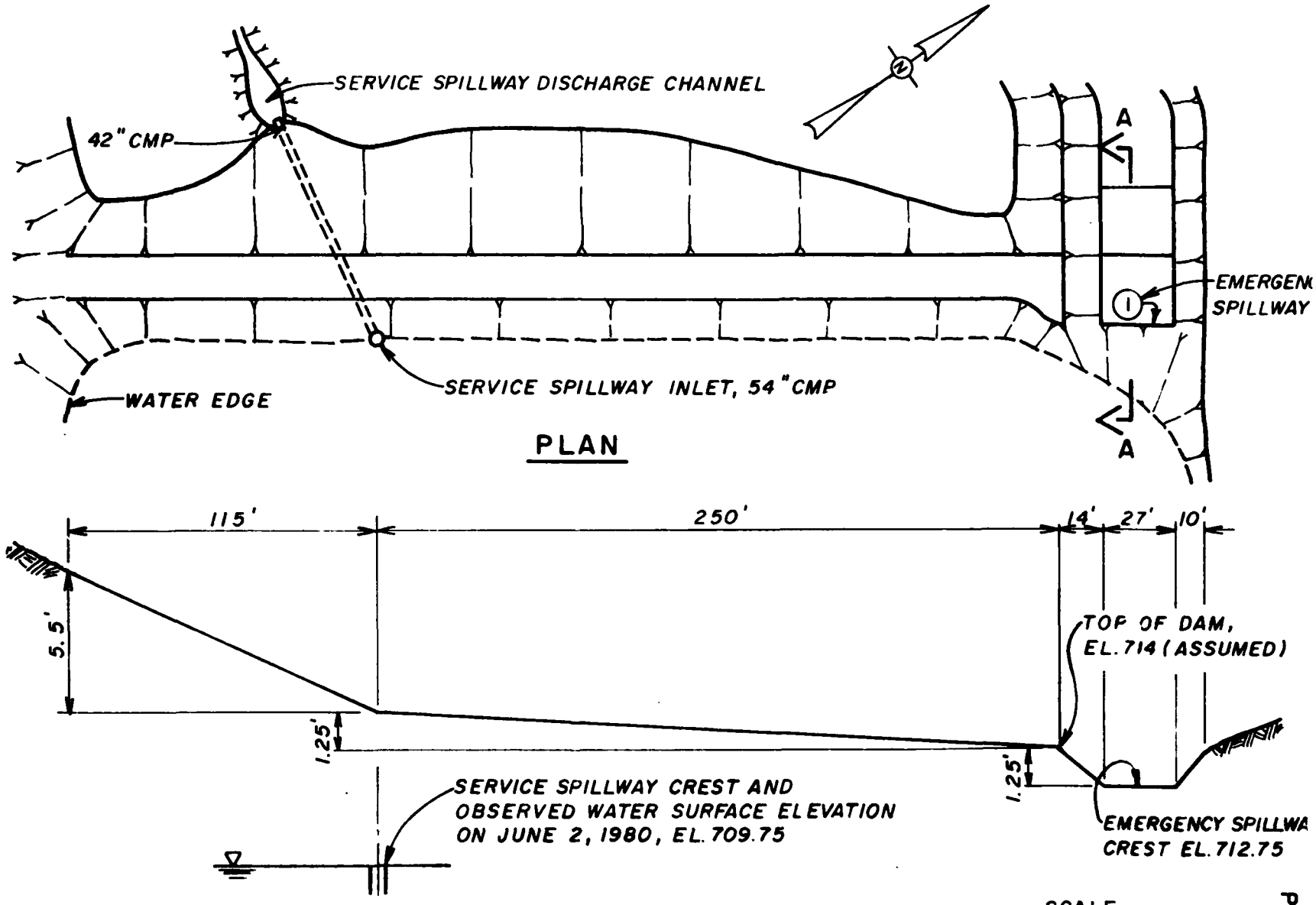
PLATES

PLATE 1



LOCATION MAP - SHADY LAKE DAM

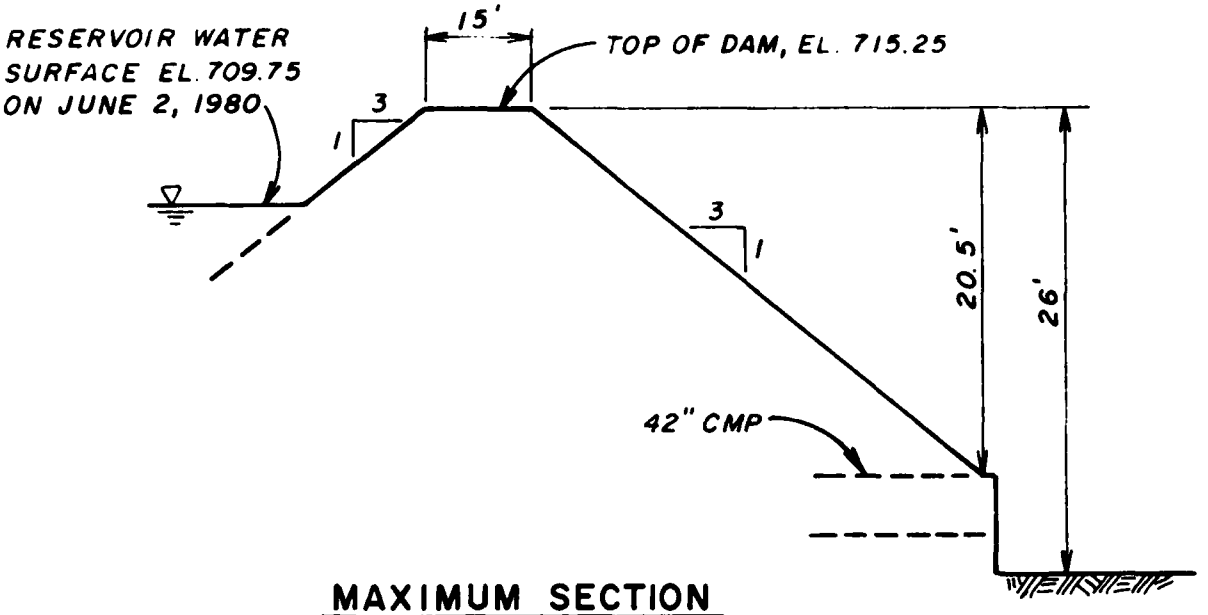
MO. 11598



SCALE
HORIZ. 1" = 50'
VERT. " = 5'

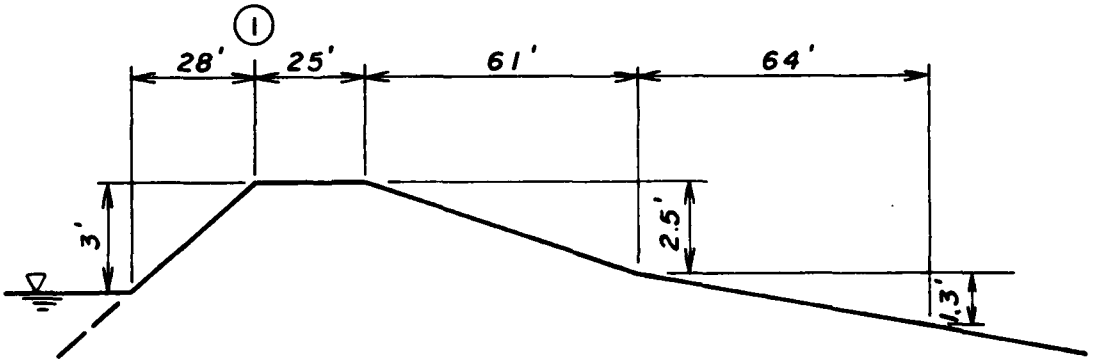
SHADY LAKE DAM (MO. 11598)
PLAN AND ELEVATION
(SHEET 1 OF 2)

PLATE 2



MAXIMUM SECTION

SCALE:
HORIZ. 1" = 25'
VERT. 1" = 10'



SECTION A-A
EMERGENCY SPILLWAY PROFILE

SCALE:
HORIZ. 1" = 40'
VERT. 1" = 5'

(1) *REFERENCE POINT SHEET 1 OF 2*

SHADY LAKE DAM (MO. 11598)
MAXIMUM SECTION OF EMBANKMENT AND EMERGENCY SPILLWAY PROFILE
(SHEET 2 OF 2)

PLATE 4

SCALE

10 0 10 20 30 40 Miles

⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 5

REFERENCE:

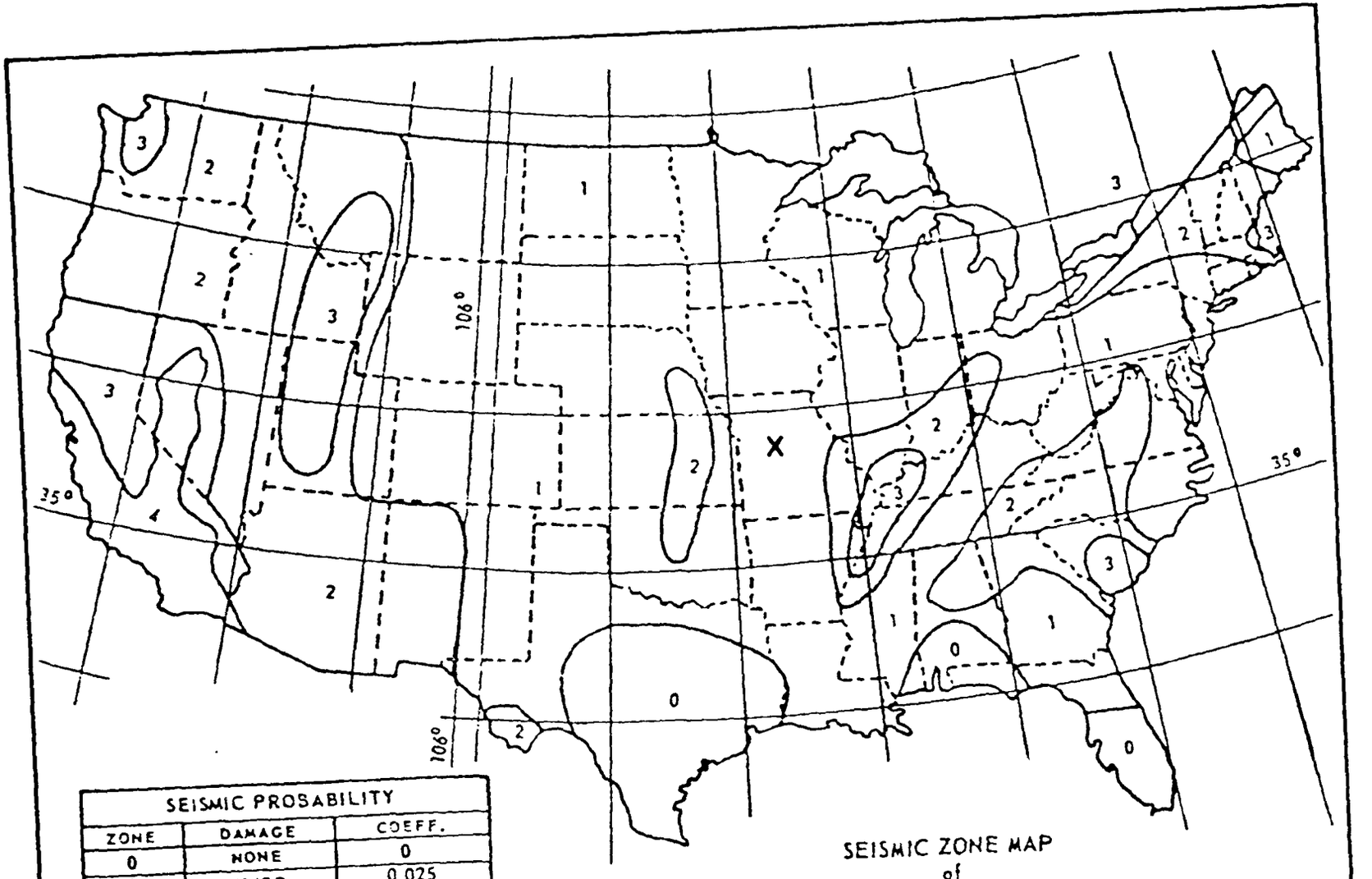
GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF SHADY LAKE DAM

SHADY LAKE DAM
PLATE 5

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	Pu	PENNSYLVANIAN UNDIFFERENTIATED
	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mo	KEOKUK - BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	CHOUTEAU GROUP: NORTHVIEW, COMPTON AND BACHELOR FORMATION (LIMESTONE AND SHALE)
DEVONIAN	D	SULPHUR SPRING GROUP: BUSHBERG SANDSTONE, GLEN PARK LIMESTONE, GRASSY CREEK SHALE
ORDOVICIAN	Osp	ST PETER SANDSTONE
	Ojc.	SMITHVILLE FORMATION, POWELL DOLOMITE



SEISMIC PROSABILITY		
ZONE	DAMAGE	COEFF.
0	NONE	0
1	MINOR	0.025
2	MODERATE	0.05
3	MAJOR	0.10
4	GREAT	0.15

X APPROXIMATE LOCATION OF SHADY LAKE DAM

SEISMIC ZONE MAP
of
CONTIGUOUS STATES

PLATE 6

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

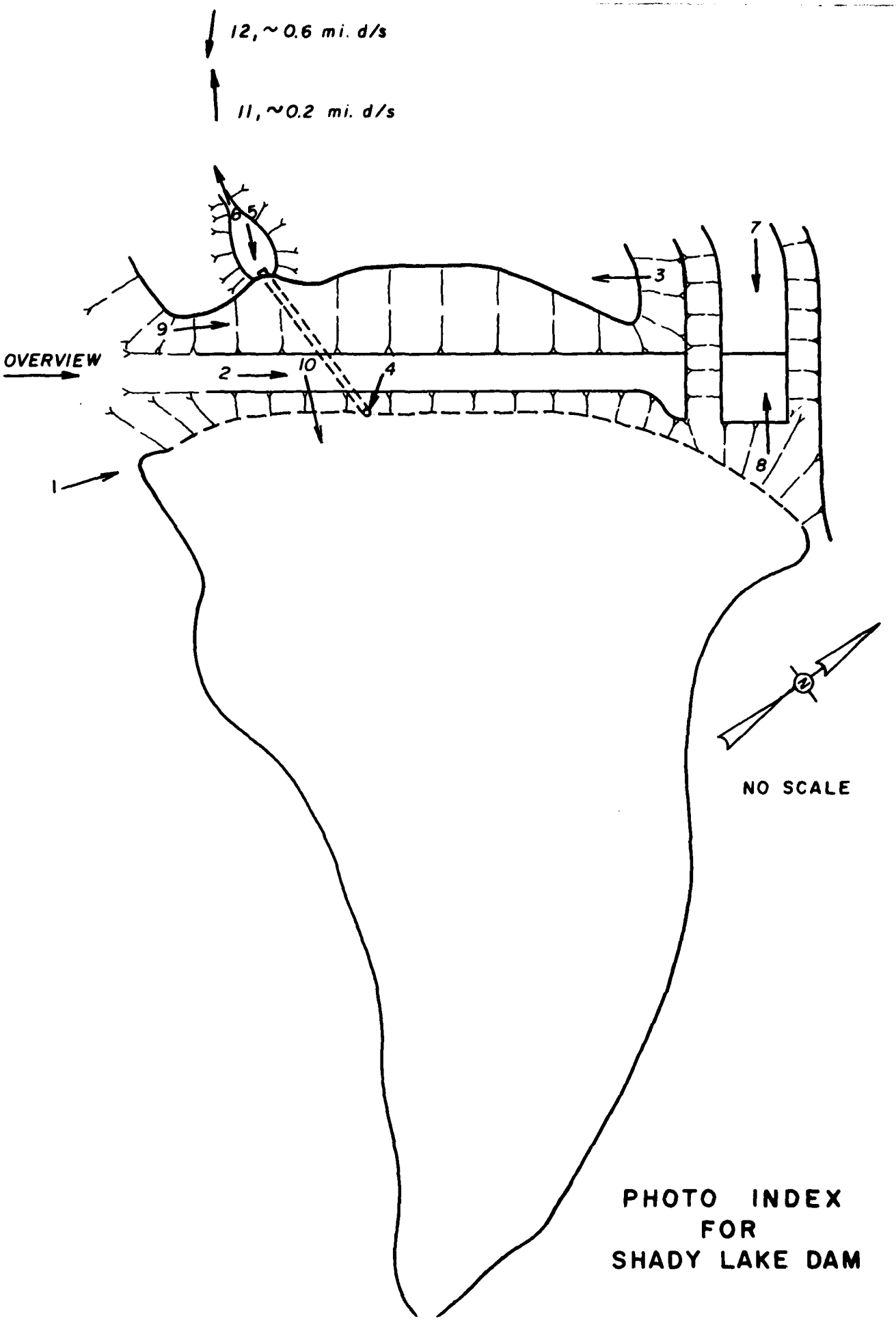


PHOTO INDEX
FOR
SHADY LAKE DAM

Shady Lake Dam

Photographs

Photo 1 - View of the upstream slope showing the location of the service spillway inlet and debris covering the inlet of the service spillway.

Photo 2 - View of the top of dam looking toward the right abutment and emergency spillway, and showing vehicular tracks.

Photo 3 - View of the downstream slope showing the trailer park above the left abutment.

Photo 4 - View of the debris covering the inlet to the service spillway. (The person's right foot is on the trashrack of the spillway)

Photo 5 - View of the outlet of the service spillway showing the limestone outcrop in the discharge channel.

Photo 6 - View of the downstream channel showing the obstruction of trees and debris.

Photo 7 - View of the emergency spillway from downstream looking toward the reservoir. (Person in center of photo is standing near the control section of the spillway). Shows two to three foot stand of fescue grass.

Photo 8 - View of the emergency spillway from the control section looking downstream.

Photo 9 - View of the downstream slope of the dam and the emergency spillway training berm; taken from near the left abutment.

Photo 10 - View of reservoir and rim; taken from the dam.

Photo 11 - View of the downstream hazard showing several dwellings to be in the possible damage zone. The Photo was taken approximately 0.2 miles downstream of the dam from the downstream channel looking downstream.

Photo 12 - View of warehouses approximately 0.6 miles downstream of the dam. The Photo was taken from the bridge for the U.S. Highway 63 crossing of Bear Creek looking upstream.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

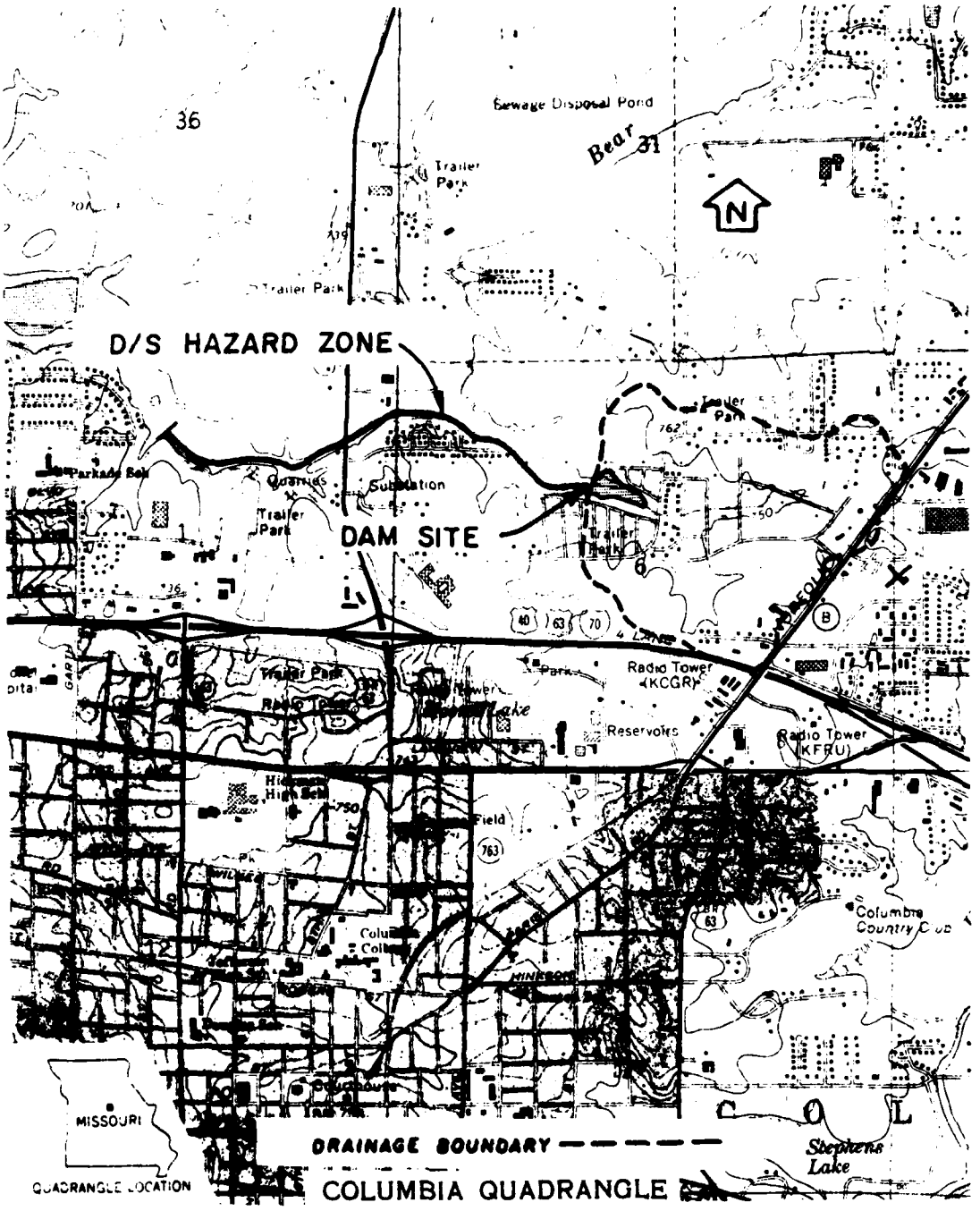
Photo 10

Photo 11

Photo 12

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



SHADY LAKE DAM (MO. 11598)
DRAINAGE BASIN AND DOWNSTREAM HAZARD ZONE

EC-4 **PRC ENGINEERING CONSULTANTS, INC.**

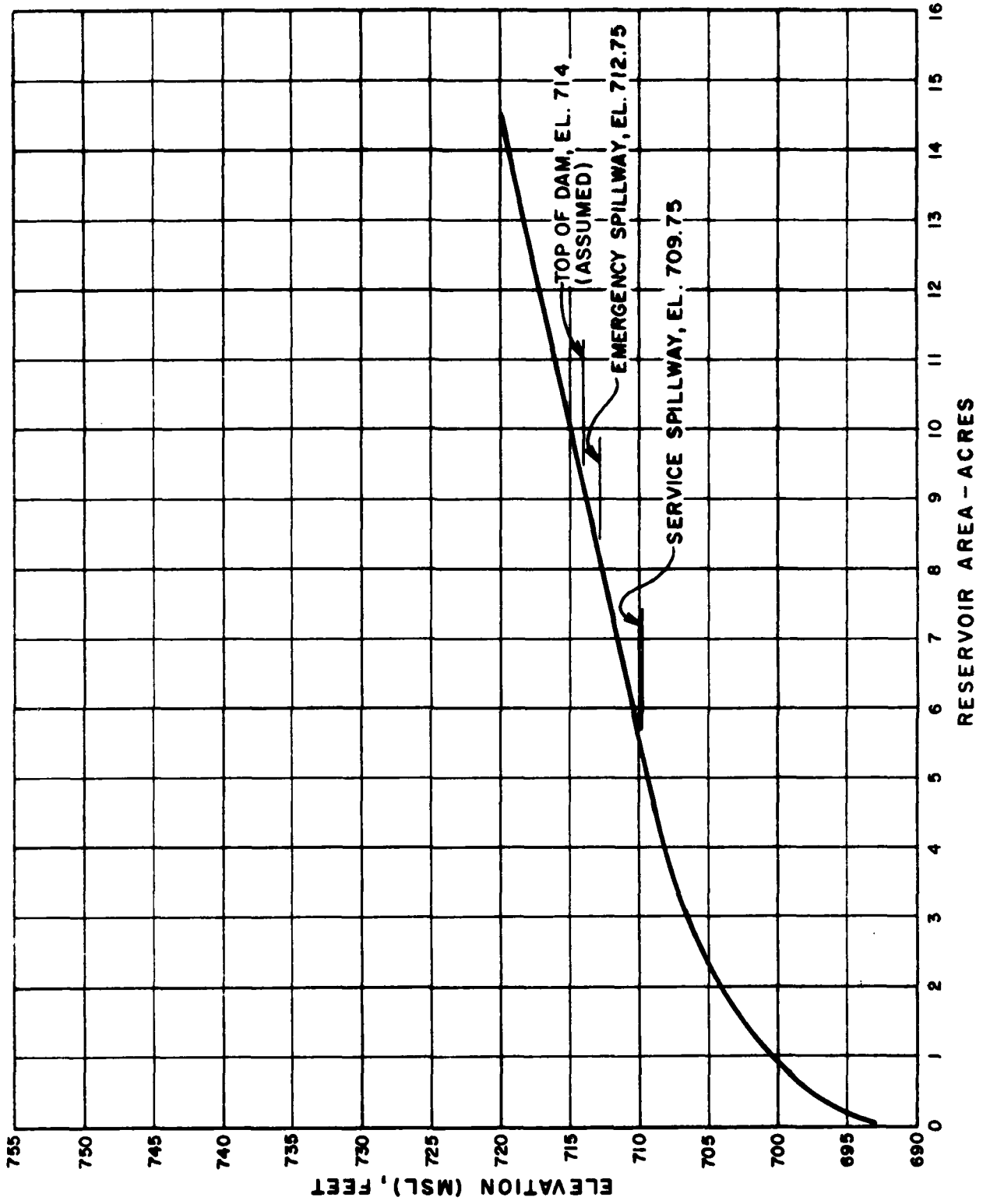
DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF 1

DAM NAME: SHALY LAKE DAM / ID NO.: 11598 JOB NO. 1263

RESERVOIR ELEVATION - AREA DATA BY DC DATE 6/12/80

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
693	0	Streambed at dam
700	1.0	Measured on USGS Map
709	4.5	Water Surface - Measured on USGS Map
709.75		(Service Spillway)
710	5	(Measured on USGS Map
712.75	8.0	Emergency Spillway Crest (Interpolated)
714.0	1.5	Top of dam (Assumed)
720	14.5	Measured on USGS Map

PLATE 2, APPENDIX B



SHADY LAKE DAM (MO. 11598)
RESERVOIR ELEVATION-AREA CURVE

PKC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 1

DAM NAME: SHADY LAKE DAM (MO 11598) — JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS — BY DC — DATE 6/18/80

1) DRAINAGE AREA, $A = .33$ sq. mi. $= (211$ acres)

2) LENGTH OF STREAM, $L = (.15'' \times 2000' = 300.') = .568$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 800'$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 709.75$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 775$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 718$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10})/0.75L = \frac{775-718}{.75(3000')} = 2.53\%$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$t_c = [(11.9 \times L^{3}(\text{miles}))/(H_1 - H_2)]^{0.385} = \left[\frac{(11.9)(.568^3)}{800 - 709.75}\right]^{.385} = .239$

B) BY VELOCITY ESTIMATE,

SLOPE = 2.5% $\Rightarrow$ AVG. VELOCITY = 3 ft/s

$t_c = L/V = 3000/3(60)(60) = .28$ hr.

USE $t_c = .239$

9) LAG TIME, $t_l = 0.6\, t_c = .14$

10) UNIT DURATION, $D \leq t_l/3 = .048$ $\quad < 0.083$ hr.

USE $D = .083$ (multiples of 5 min.)

11) TIME TO PEAK, $T_p = D/2 + t_l = .182$

12) PEAK DISCHARGE,

$q_p = (484 \times A)/T_p = 484 \times 0.33/0.182 = 878$ cfs

(A in sq miles)

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. 1 OF 1

DAM NAME: SHADY LAKE DAM (MO 11548) JOB NO. 1263

CURVE NUMBER DETERMINATION BY JFK KLB DATE 7/14/80

I) SOIL GROUP

WATERSHED SOILS IN THE BASIN CONSIST OF:

PERSHING (C) - ARMSTRONG (D) - GARA (C)

GROUP C SOILS SEEM TO PREDOMINATE THE BASIN. THEREFORE, ASSUME GROUP C SOILS FOR THE ENTIRE WATERSHED FOR HYDROLOGIC PURPOSES.

II) COVER COMPLEX

ASSUMED LAND USE	ASSUMED HYDROLOGIC CONDITION	PER CENT AREA	CN (AMC II)
WOODS	FAIR	20	73
RANGE	FAIR	50	79
URBAN	FAIR	30	90

III) CURVE NUMBER

WEIGHTED AVERAGE CN = 81 FOR AMC II

CURVE NUMBER = 92 FOR AMC III

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 3

DAM NAME: SHADY LAKE DAM (MO 11598) — JOB NO. 1263

PROBABLE MAXIMUM PRECIPITATION — BY D.C KLB — DATE 6-18-80

DETERMINATION OF PMP

1) Determine drainage area of the basin

D.A. = 211 acres (.33 sq mi)

2) Determine PMP Index Rainfall (for D.A. = 200 sq. mi. & 24 hr duration)

Location of centroid of basin,

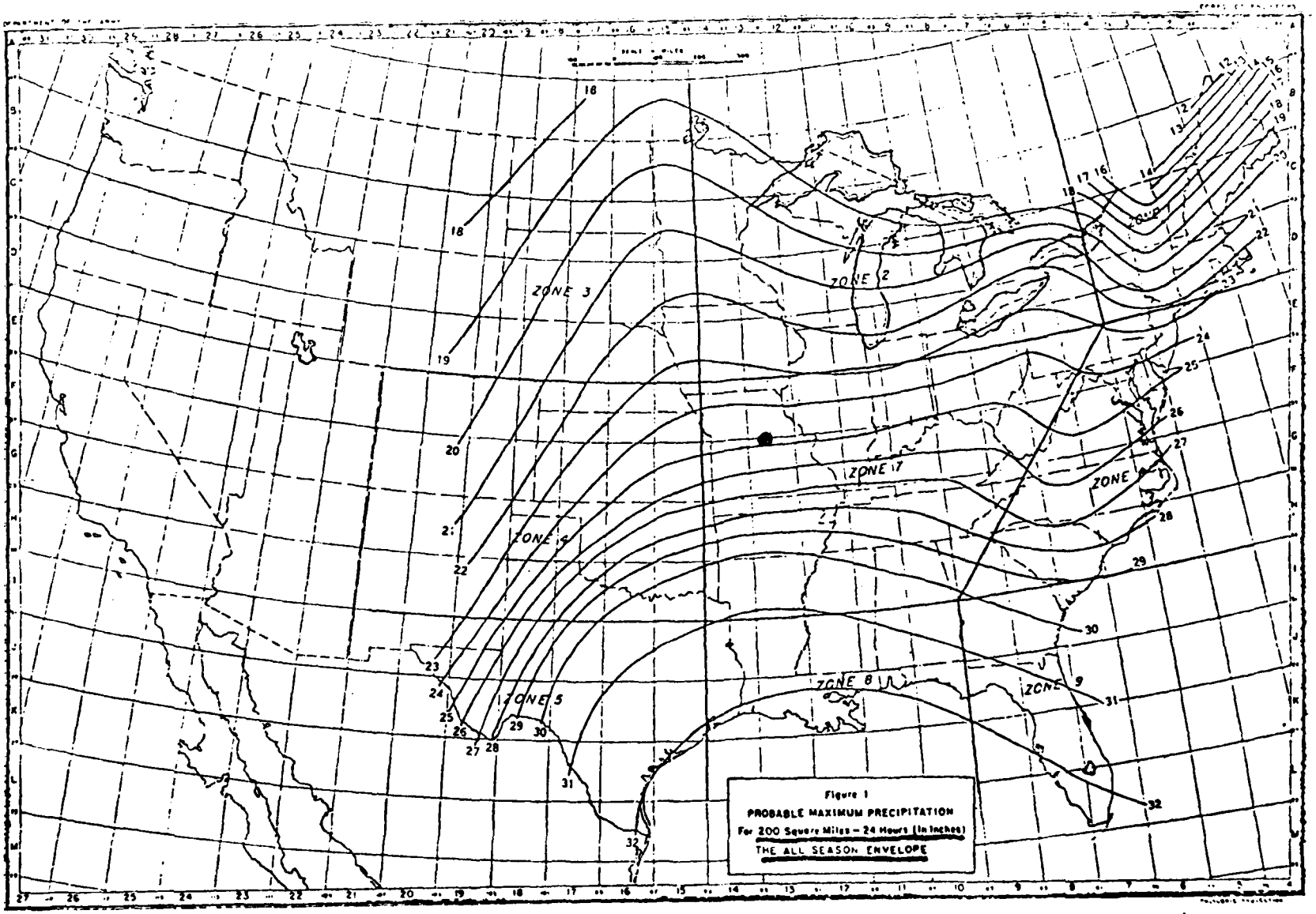
Long. = 92° 18' 32" Lat. = 38° 58' 18"

PMP = 24.9" (from Fig. 1, HMR 33)

Zone = 7

3) Determine basin rainfall in terms of percentage of PMP Index Rainfall for various durations. (from Fig. 2, HMR 33)

Duration (Hrs.)	Percent of Index Rainfall (%)	Total Rainfall (Inches)	Rainfall Increments (Inches)	Duration of Increment (Hrs.)
6	100	24.9	24.9	6
12	120	29.9	5	6
24	130	32.4	2.5	12



⊕ Location of Basin Centroid

Shady Lake Dam (MO. 11598)

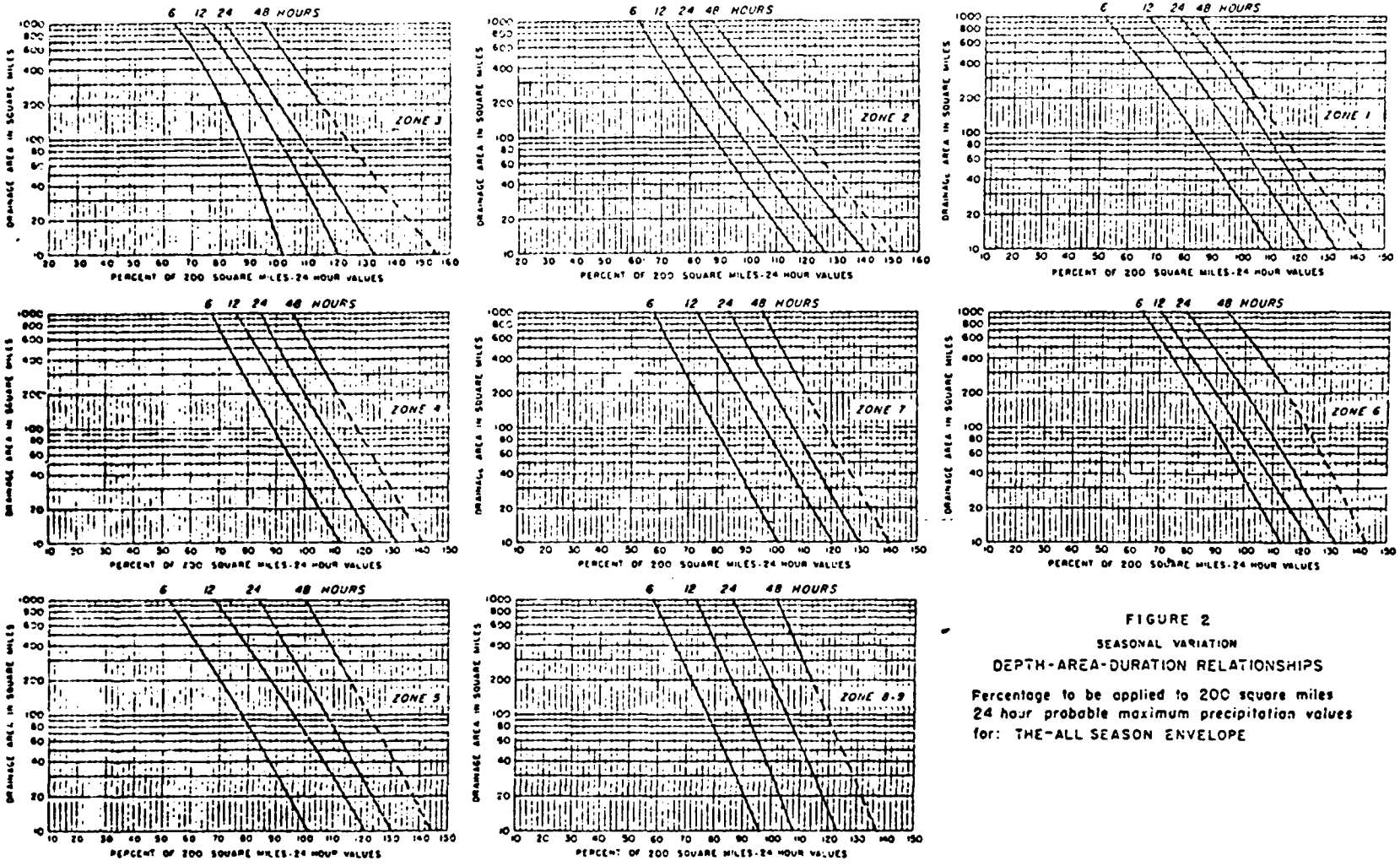


FIGURE 2

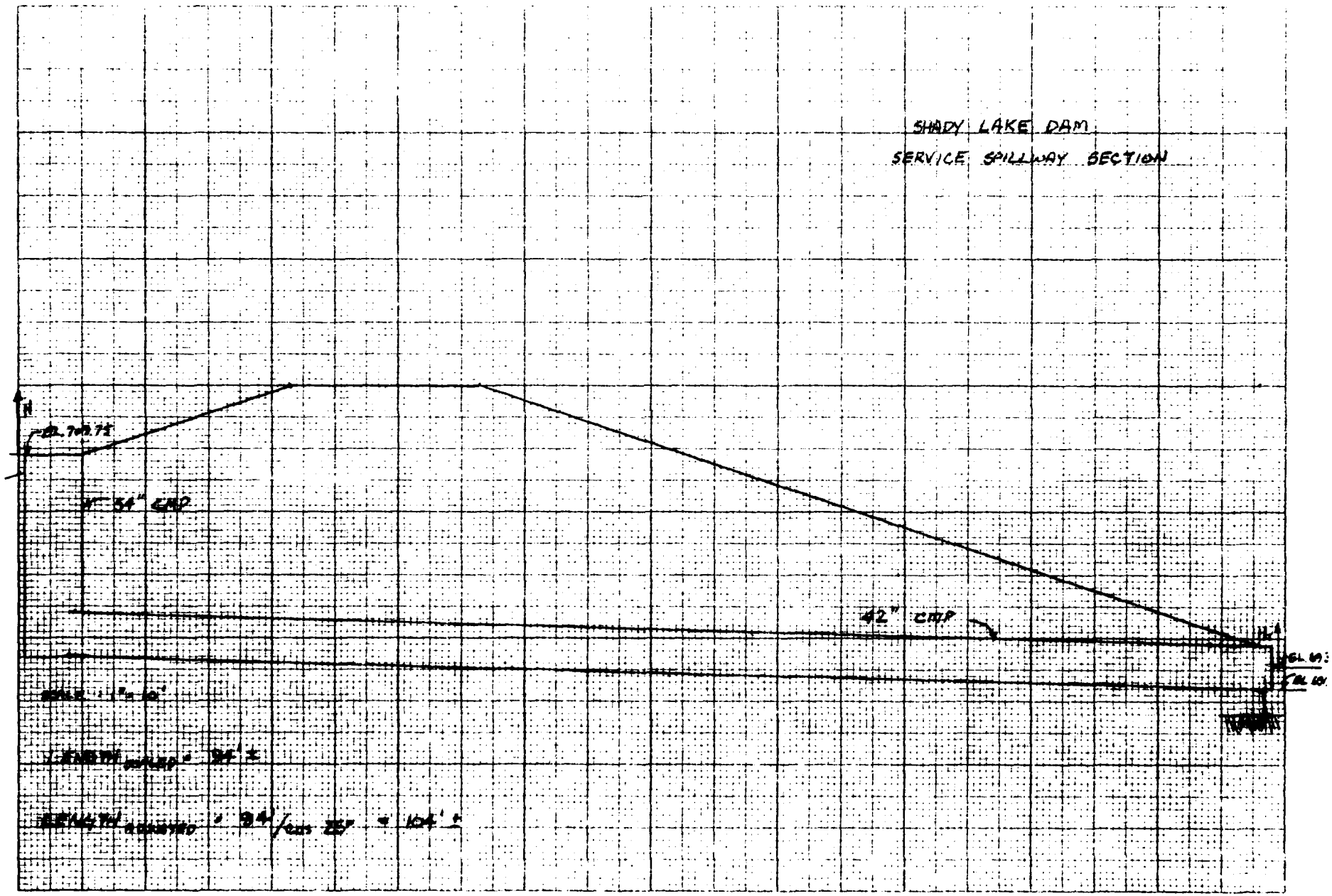
SEASONAL VARIATION

DEPTH-AREA-DURATION RELATIONSHIPS

Percentage to be applied to 200 square miles 24 hour probable maximum precipitation values for: THE-ALL SEASON ENVELOPE

SHADY LAKE DAM

SERVICE SPILLWAY SECTION



for Weir Flow:

$Q = CLH^{1.5}$, $C = 3.3$ (assumed)
$L = \pi D = \pi(4.5) = 14.14$
H: W.S. ELEV. - 709.75

$Q = 46.7(H)^{1.5}$

for Orifice Flow:

$Q = CA\sqrt{2gH}$, $C = 0.6$
$A = \pi D^2/4 = \pi(4.5)^2/4 = 15.9$
H = W.S. ELEV - 709.75

$Q = 76.56\sqrt{H}$

for Pressure Flow:

$H_T = (\Sigma K)\, V^2/2g$

$V = \left(\frac{2g}{\Sigma K} H_T\right)^{1/2}$

$Q = VA$, where

$K_{entrance} = 0.5$

$K_{friction(4.5)} = 29.1 \frac{n^2 L}{R^{4/3}} = 29.1 \frac{(0.024)^2 (16)}{(1.125)^{4/3}} = 0.23$

$K_{bend\ \&\ contraction} = 0.5$

$K_{friction(3.5')} = 29.1 \frac{n^2 L}{R^{4/3}} = 29.1 \frac{(0.024)^2 (104)}{(0.875)^{4/3}} = 2.08$

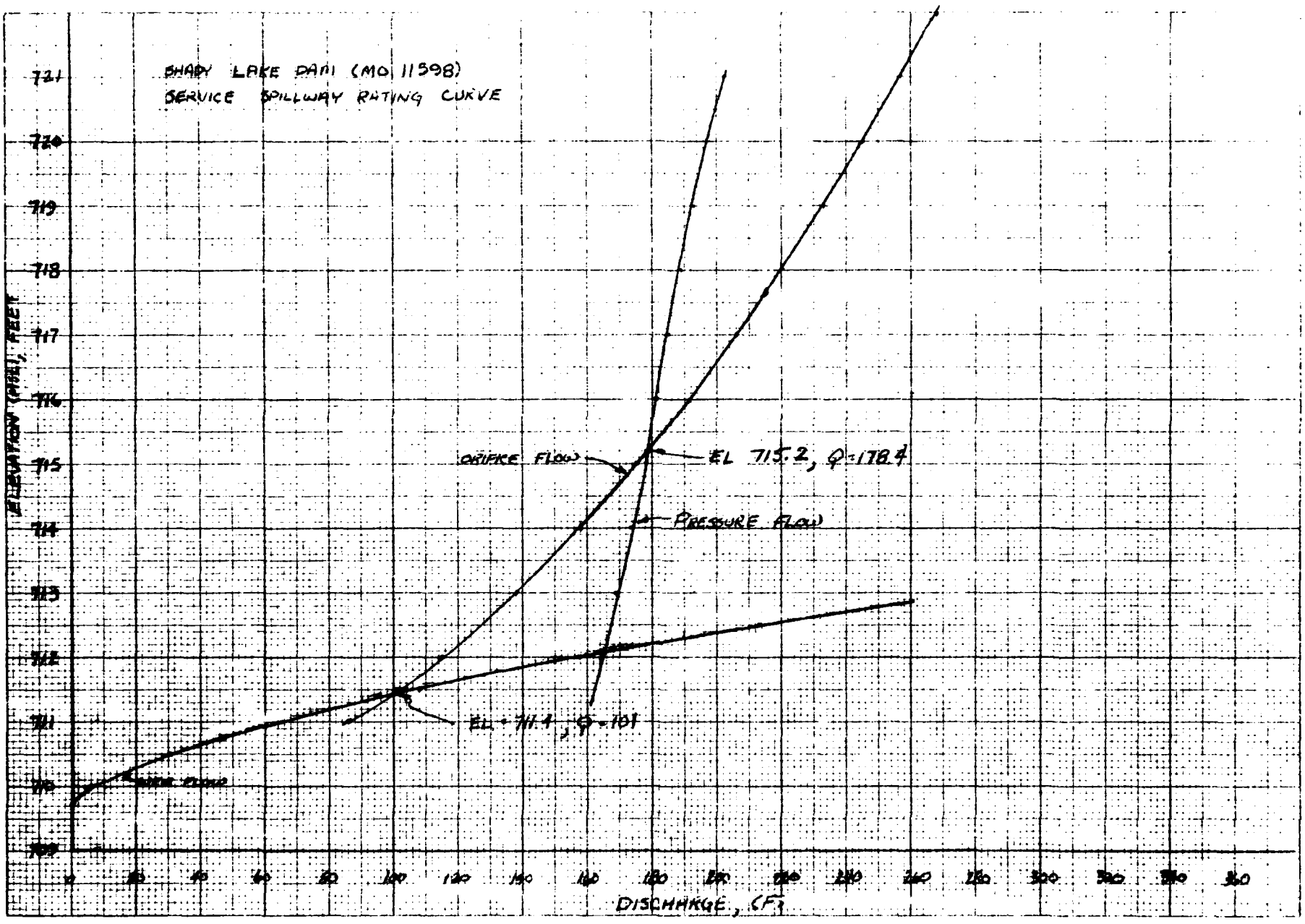
$K_{exit} = 1.0$

$$\Sigma K = 0.5 + 0.23\left(\frac{3.5}{4.5}\right)^4 + 0.5 + 2.08 + 1.0 = 4.16$$

$$V = \left(\frac{2g}{4.16} H_T\right)^{1/2} = 3.93\sqrt{H_T}$$

$$Q = 3.93\sqrt{H_T}\ \pi\ (3.5)^2/4$$

$$Q = 37.85\sqrt{H_T}\ , \quad H_T = \text{W.S. ELEV} - 693$$

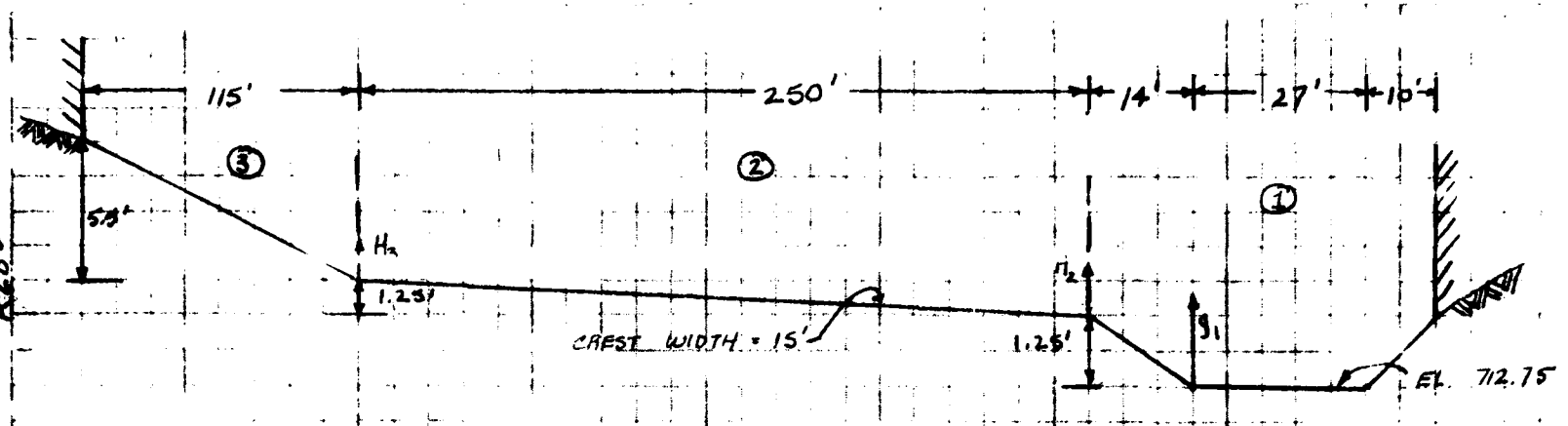

SHADY LAKE DAM (MO 11598)
SERVICE SPILLWAY RATING CURVE
ELEVATION (MSL), FEET
DISCHARGE, CFS
ORIFICE FLOW
PRESSURE FLOW
EL 715.2, Q=178.4
EL. 711.1, Q=101

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. 1 OF 2

BIDDY LAKE DAM (MO. 11598) JOB NO. 1263

EMERGENCY SPILLWAY AND OVERTOP RATING CURVE BY JEK DATE 7/15/80

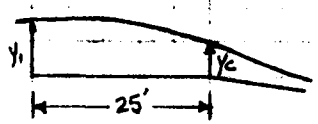


SECTION 1: at critical section,

for $0 < y_c \leq 1.25$, $T = 27 + 19.2\,y_c$
$A = y_c(T - 9.6\,y_c)$

for $1.25 < y_c$, $T = 51$
$A = 51\,y_c - 15$

at the upstream section, at the dam, y_1 was determined from a backwater analysis using HEC-2



SECTION 2:

for $0 < y_{c_2} \leq 1.25$, $y_{c_2} = 4/5\,H_2$
$T = 200\,y_{c_2}$
$A = T y_{c_2}/2$

for $1.25 \leq y_{c_2}$, $y_{c_2} = 2/3\,(H_2 + 0.313)$
$T = 200$
$A = T y_{c_2} - 156.25$

H_2 = W.S. ELEV. - 714

SECTION 3:

for $0 < y_{c_3} < 5.5$, $y_{c_3} = 4/5\,H_3$
$T = 20.91\,y_{c_3}$
$A = T y_{c_3}/2$

for $5.5 \leq y_{c_3}$, $y_{c_3} = 2/3\,(H_3 + 1.375)$
$T = 115$
$A = T y_{c_3} - 316.25$

$H_3 = H_2 + 1.25$

PRC ENGINEERING CONSULTANTS, INC.

SHEET NO. [illegible]

EMERGENCY SPILLWAY AND OVERTOP RATING CURVE BY JFK DATE 7/15/80

HAND CALCULATIONS TO VERIFY RESULTS FROM HEC-2

Y_c	T_c	A_c	$V_c=\sqrt{\frac{A_c g}{T_c}}$	$Q=V_c A_c$	Y_1	A_1	P_1	$S_1 \times 10^{-4}$	$V_1^*=\frac{1.49}{n}R^{2/3}S^{1/2}$	$V_1^2/2g$	W.S. ELEV. $712.75+Y_1^*+V_1^2/2g$	H_2	Y_2	T_2	A_2	$Q_2=\sqrt{\frac{A_2^3 g}{T_2}}$
0	0	0	0	0	0	0	0	0	0	0	712.25					
0.16	30.04	4.52	2.21	10	0.34	10.37	33.58	18.16	0.96	.01	713.10					
0.45	35.58	13.99	3.57	50	0.75	25.51	41.34	29.86	1.96	.06	713.56					
0.69	40.21	23.13	4.32	100	1.06	39.21	47.27	34.11	2.55	.10	713.91					
0.88	43.88	31.16	4.81	150	1.29	50.69	51.13	36.19	2.96	.14	714.17	0.17	.14	27.20	1.85	2.7
1.05	47.10	38.79	5.16	200	1.47	60.14	51.13	36.73	3.33	.17	714.39	0.39	.31	62.40	9.73	21.8
1.19	49.92	45.91	5.45	250	1.63	68.36	51.13	37.76	3.66	.21	714.59	0.59	.47	94.40	22.28	61.4
1.31	51.0	51.91	5.78	300	1.78	75.84	51.13	38.75	3.96	.24	714.77	0.77	.62	[illegible]	37.95	119.5
1.42	51.0	57.54	6.08	350	1.91	82.82	51.13	39.60	4.23	.28	714.94	0.94	.75	[illegible]	56.55	196.8
1.53	51.0	63.02	6.35	400	2.04	89.44	51.13	40.30	4.47	.31	715.10	1.10	[illegible]	176	77.[illegible]	291.5
1.63	51.0	68.07	6.61	450	2.16	95.16	51.13	41.71	4.73	.35	715.26	1.26	1.01	201.6	101.[illegible]	[illegible]
1.73	51.0	73.05	6.84	500	2.28	101.04	51.13	42.41	4.95	.38	715.41	1.41	1.13	225.6	[illegible]	542.[illegible]
2.18	51.0	96.13	7.80	750	2.80	127.43	51.13	45.18	5.89	.54	716.08	2.08	1.60	250	242.5	1355.3
2.58	51.0	116.44	8.59	1000	3.25	150.54	51.13	47.12	6.64	.69	716.69	2.69	2.00	250	344.17	2291.5
2.94	51.0	134.71	9.28	1250	3.68	172.71	51.13	47.55	7.24	.81	717.24	3.24	2.37	250	[illegible]	3266.4

* n = 0.03

H_3	Y_3	T_3	A_3	$Q_3=\sqrt{\frac{A_3^3 g}{T_3}}$	$Q_{TOTAL}=Q+Q_2+Q_3$	W.S. ELEV
					0	712.75
					10	713.10
					50	713.56
					100	713.91
					153	714.17
					222	714.39
					311	714.59
					420	714.77
					547	714.94
					692	715.10
0.01	.01	0.17	.0007	0.0	859	715.26
0.16	.13	2.68	0.17	0.3	1043	715.41
0.83	.66	13.88	4.61	15.07	2120	716.08
1.44	1.15	24.09	13.87	59.8	3351	716.69
1.99	1.59	33.29	26.50	134.2	4650	717.24

PRC ENGINEERING CONSULTANTS, INC.

[illegible] MISSOURI 1980 SHEET NO. 1 OF 1

SHADY LAKE DAM (MO 11598) JOB NO. 1263

EMERGENCY SPILLWAY SLOPE BY JFK KLB DATE 7/16/80

$Slope_{bed} = 1.3'/64' = 0.0203$ (mildest)

$$S_c = \left[Q \frac{n}{1.49} \frac{1}{A} \frac{1}{R^{2/3}} \right]^2$$

for $y = 0.45$, $Q = 50$
$A = 13.99$
$R = 0.39$

$$S_c = \left[50 \frac{(0.03)}{1.49} \frac{1}{13.99} \frac{1}{(0.39)^{2/3}} \right]^2 = 0.018 < 0.0203 \quad O.K.$$

for $y = 1.31$, $Q = 300$
$A = 51.91$
$R = 1.02$

$$S_c = \left[300 \frac{(0.03)}{1.49} \frac{1}{51.91} \frac{1}{(1.02)^{2/3}} \right]^2 = 0.0132 < 0.0203 \quad O.K.$$

∴ The assumption of critical depth at the emergency spillway is valid.

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. 1 OF 1

SHADY LAKE DAM (MO. 11598) JOB NO. 1263

COMBINED RATING CURVE BY JEK DATE 7/15/80

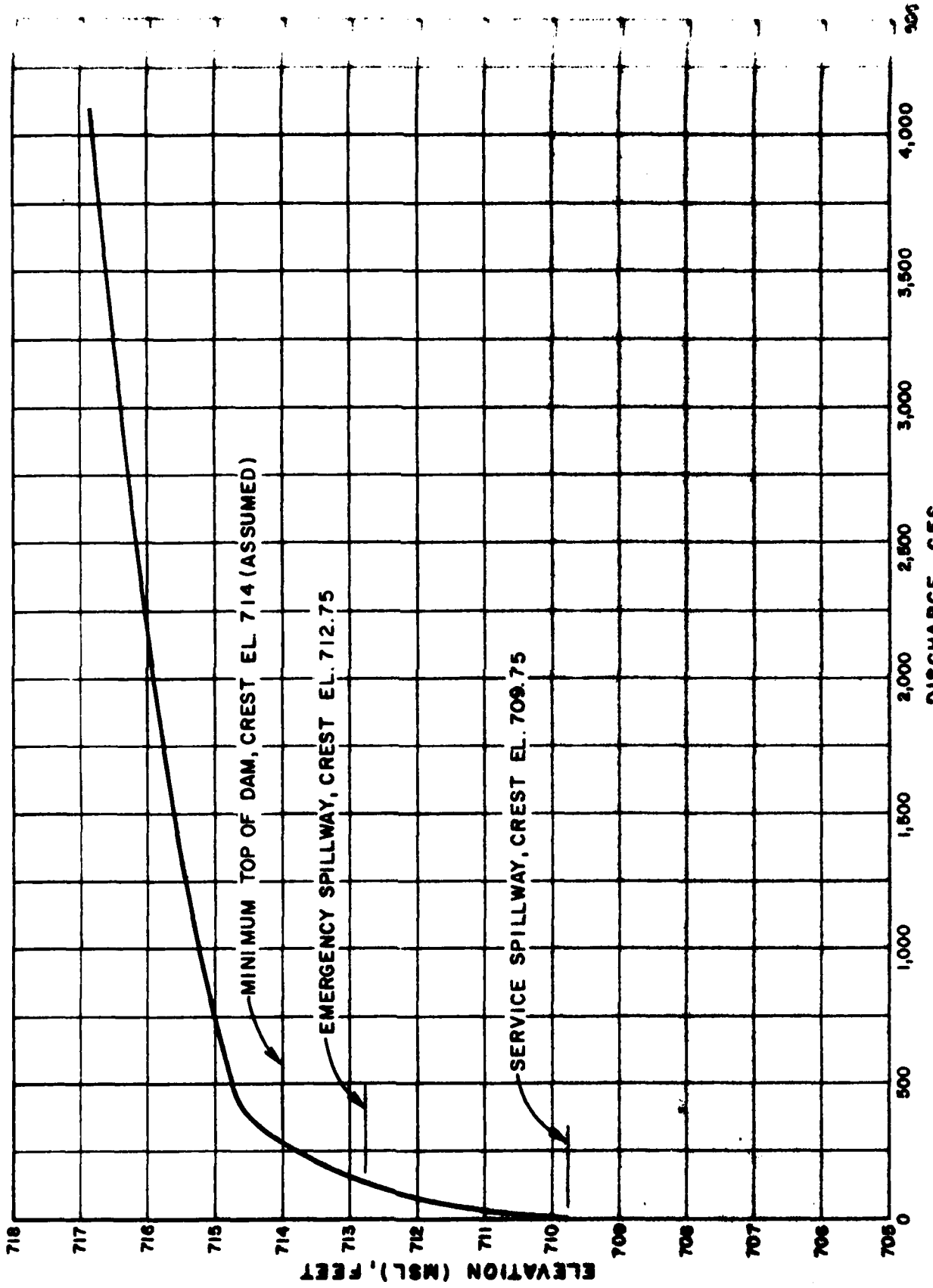
SERVICE SPILLWAY, EMERGENCY SPILLWAY, AND OVERTOP RATING CURVE

W.S. ELEV.	H or H_T	$Q_{SERVICE\ SPLWY}$	$Q_{EMERGNCY\ \&\ O.T.}$	Q_{TOTAL}
709.75	0	0		0
710	0.25	5.8*		6
711	1.25	65.3*		65
711.5	1.75	101.3		101
712	2.25	114.8		115
712.75	3.0	132.6	0	133
713.1	3.35	140.1	10	150
713.56	3.81	149.4	50	199
713.91	4.16	156.2	100	256
714.17	4.42	161	153	314
714.39	4.64	164.9	222	387
714.59	4.84	168.4	311	479
714.77	5.02	171.5	420	592
714.94	5.19	174.4	547	721
715.10	5.35	177.1	692	869
715.26	22.26	178.6**	859	1038
715.41	22.41	179.2**	1043	1222
716.08	23.08	181.9**	2120	2302
716.69	23.69	184.2**	3351	3595
717.24	24.24	186.4**	4650	4836

* Weir flow controls ($Q = 46.7 H^{1.5}$, where H = W.S. ELEV - 709.75). For W.S. ELEV. 711.5 to 715.1, orifice flow controls ($Q = 76.56 \sqrt{H}$, where H = W.S. ELEV - 709.75).

** Pressure flow controls from W.S. ELEV = 715.2 and above, where $Q = 37.86 \sqrt{H_T}$ and H_T = W.S. ELEV - 693.

PLATE 3, APPENDIX B



SHADY LAKE DAM (MD. 11598)
SPILLWAY AND OVERTOP RATING CURVE

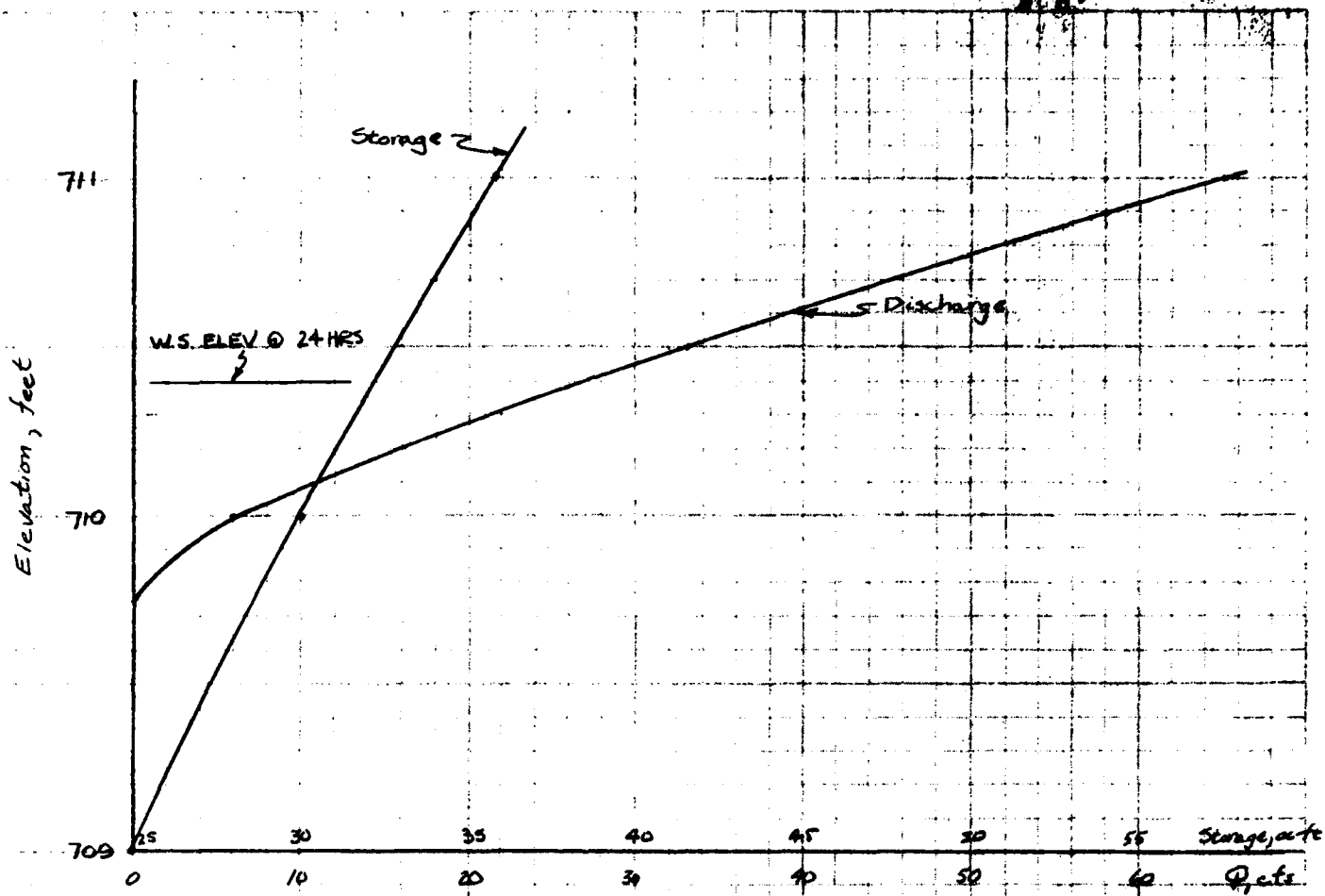
EC1-4

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI - 1980 — SHEET NO. 1 OF 1

SHADY LAKE DAM (MO 11598) — JOB NO. 4263

STARTING W.S. ELEV. FOR PMF ROUTING — BY [illegible] DATE 7/17/80



W.S. ELEV. i	W.S ELEV. f	Δ STORAGE	Q AVERAGE	Δ TIME (HRS)
710.4	710.3	0.6	21.7	0.34
710.3	710.2	0.6	16.5	0.44
710.2	710.1	0.6	11.8	0.62
710.1	710	0.5	7.7	0.79
710	709.9	0.5	4.2	1.44
709.9	709.8	0.5	1.5	4.03
709.8	709.75	0.4	0.5	9.68
			Σ = 17.54	• 0.7 + 1 = 1.7 days < 4 days

∴ Start PMF, ½ PMF, and ⅞ PMF routings at Service Spillway Crest

HEC1DB INPUT DATA

```
*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
*********************************
     1          A1                    DAM SAFETY INSPECTION-MISSOURI
     2          A2                        SHADY LAKE DAM (MO 11598)
     3          A3                      PMF AND 50 PERCENT PMF
     4          B     300       0       5       0       0       0       0       0       0
     5          B1      5
     6          J       1       2       1
     7          J1      1      .5
     8          K       0 MO11598                                       1
     9          K1     INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMPTERS
    10          M       1       2     .33             .33       1                       1
    11          P            24.9     100     120     130
    12          T                                                     -1     -92
    13          W2            .14
    14          X       0       0       1
    15          K       1 MO11598                                       1
    16          K1     ROUTE HYDROGRAPH THROUGH SHADY LAKE DAM (MO 11598)
    17          Y                               1       1
    18          Y1      1                                          -709.75      -1
    19          Y4709.75     710     711   711.5     712  712.75   713.1  713.56  713.91  714.1
    20          Y4714.39  714.59  714.77  714.94   715.1  715.26  715.41  716.08  716.69  717.[illegible]
    21          Y5              6      65     101     115     133     150     199     256     3[illegible]
    22          Y5    387     479     592     721     869    1038    1222    2302    3535    48[illegible]
    23          $A      0       1     4.5     5.5       8     9.5    14.5
    24          $E    693     700     709     710  712.75     714     720
    25          $$709.75
    26          $D    714
    27          K      99
```

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 011598
ROUTE HYDROGRAPH TO 011[illegible]
END OF NETWORK

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 80/07/21.
     TIME= 07.59.41.
```

DAM SAFETY INSPECTION-MINSOFI
SHADY LAKE DAM (MO 11596)
PMF AND 50 PERCENT PMF

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	0	0

JOPER	NRT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

SUB-AREA RUNOFF COMPUTATION

INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMETERS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
011596	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.33	0.00	.33	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.50	140.00	170.00	130.00	0.00	0.00	0.00

LOSS DATA

LOSS	STRTL	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-99.00	0.00	0.00

CURVE NO = -99.00 WETNESS = -1.00 EFFECT CN = 99.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .14

RECESSION DATA

STRTQ= 0.00 QRCSN= -0.00 RTIOR= 1.00

TIME INCREMENT TOO LARGE--LNHR IS GT LAG/2)

UNIT HYDROGRAPH 14 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .14 VOL= 1.00

	356.	874.	784.	525.	158.	74.	39.	17.	84	4.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO&DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.55	151	.21	.21	.00	519.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.21	.21	.00	522.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.21	.21	.00	523.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.00	524.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.21	.00	525.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.21	.00	526.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.25	.25	.00	540.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.25	.25	.00	576.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.25	.25	.00	605.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.25	.25	.00	619.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.25	161	.25	.25	.00	625.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.25	.25	.00	628.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.35	163	.25	.25	.00	630.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.40	164	.25	.25	.00	631.
1.01	1.15	15	.01	.00	.01	1.	1.01	13.45	165	.25	.25	.00	632.
1.01	1.20	16	.01	.00	.01	1.	1.01	13.50	166	.25	.25	.00	632.
1.01	1.25	17	.01	.00	.01	2.	1.01	13.55	167	.25	.25	.00	632.
1.01	1.30	18	.01	.00	.01	3.	1.01	14.00	168	.25	.25	.00	632.
1.01	1.35	19	.01	.00	.01	4.	1.01	14.05	169	.31	.31	.00	655.
1.01	1.40	20	.01	.00	.01	5.	1.01	14.10	170	.31	.31	.00	709.
1.01	1.45	21	.01	.00	.01	6.	1.01	14.15	171	.31	.31	.00	753.
1.01	1.50	22	.01	.00	.01	7.	1.01	14.20	172	.31	.31	.00	773.
1.01	1.55	23	.01	.00	.01	8.	1.01	14.25	173	.31	.31	.00	783.
1.01	2.00	24	.01	.00	.01	8.	1.01	14.30	174	.31	.31	.00	788.
1.01	2.05	25	.01	.00	.01	9.	1.01	14.35	175	.31	.31	.00	790.
1.01	2.10	26	.01	.00	.01	10.	1.01	14.40	176	.31	.31	.00	791.
1.01	2.15	27	.01	.00	.01	10.	1.01	14.45	177	.31	.31	.00	792.
1.01	2.20	28	.01	.00	.01	11.	1.01	14.50	178	.31	.31	.00	792.
1.01	2.25	29	.01	.01	.01	12.	1.01	14.55	179	.31	.31	.00	792.
1.01	2.30	30	.01	.01	.01	12.	1.01	15.00	180	.31	.31	.00	792.
1.01	2.35	31	.01	.01	.01	13.	1.01	15.05	181	.19	.19	.00	749.
1.01	2.40	32	.01	.01	.01	13.	1.01	15.10	182	.38	.38	.00	710.
1.01	2.45	33	.01	.01	.01	14.	1.01	15.15	183	.38	.38	.00	789.
1.01	2.50	34	.01	.01	.01	15.	1.01	15.20	184	.57	.57	.00	958.
1.01	2.55	35	.01	.01	.01	15.	1.01	15.25	185	.66	.66	.00	1191.
1.01	3.00	36	.01	.01	.01	16.	1.01	15.30	186	1.61	1.61	.00	1783.
1.01	3.05	37	.01	.01	.01	16.	1.01	15.35	187	2.65	2.64	.00	3096.
1.01	3.10	38	.01	.01	.01	16.	1.01	15.40	188	1.04	1.04	.00	4153.
1.01	3.15	39	.01	.01	.01	17.	1.01	15.45	189	.66	.66	.00	3894.
1.01	3.20	40	.01	.01	.01	17.	1.01	15.50	190	.57	.57	.00	3761.
1.01	3.25	41	.01	.01	.01	18.	1.01	15.55	191	.38	.38	.00	3307.
1.01	3.30	42	.01	.01	.01	18.	1.01	16.00	192	.38	.38	.00	1913.
1.01	3.35	43	.01	.01	.01	18.	1.01	16.05	193	.29	.29	.00	1182.
1.01	3.40	44	.01	.01	.01	19.	1.01	16.10	194	.29	.29	.00	988.
1.01	3.45	45	.01	.01	.01	19.	1.01	16.15	195	.29	.29	.00	846.
1.01	3.50	46	.01	.01	.01	20.	1.01	16.20	196	.29	.29	.00	802.
1.01	3.55	47	.01	.01	.01	20.	1.01	16.25	197	.29	.29	.00	781.
1.01	4.00	48	.01	.01	.01	20.	1.01	16.30	198	.29	.29	.00	769.
1.01	4.05	49	.01	.01	.01	20.	1.01	16.35	199	.29	.29	.00	764.
1.01	4.10	50	.01	.01	.01	21.	1.01	16.40	200	.29	.29	.00	762.
1.01	4.15	51	.01	.01	.01	21.	1.01	16.45	201	.29	.29	.00	762.
1.01	4.20	52	.01	.01	.01	21.	1.01	16.50	202	.29	.29	.00	761.
1.01	4.25	53	.01	.01	.01	22.	1.01	16.55	203	.29	.29	.00	761.
1.01	4.30	54	.01	.01	.01	22.	1.01	17.00	204	.29	.29	.00	761.
1.01	4.35	55	.01	.01	.00	22.	1.01	17.05	205	.23	.23	.00	759.

1.01	4.40	56	.01	.01	.00	22.	1.01	17.10	206	.23	.23	.00	668.
1.01	4.45	57	.01	.01	.00	23.	1.01	17.15	207	.23	.23	.00	671.
1.01	4.50	58	.01	.01	.00	23.	1.01	17.20	208	.23	.23	.00	674.
1.01	4.55	59	.01	.01	.00	23.	1.01	17.25	209	.23	.23	.00	991.
1.01	5.00	60	.01	.01	.00	23.	1.01	17.30	210	.23	.23	.00	586.
1.01	5.05	61	.01	.01	.00	24.	1.01	17.35	211	.23	.23	.00	584.
1.01	5.10	62	.01	.01	.00	24.	1.01	17.40	212	.23	.23	.00	581.
1.01	5.15	63	.01	.01	.00	24.	1.01	17.45	213	.23	.23	.00	583.
1.01	5.20	64	.01	.01	.00	24.	1.01	17.50	214	.23	.23	.00	583.
1.01	5.25	65	.01	.01	.00	24.	1.01	17.55	215	.23	.23	.00	583.
1.01	5.30	66	.01	.01	.00	25.	1.01	18.00	216	.23	.23	.00	583.
1.01	5.35	67	.01	.01	.00	25.	1.01	18.05	217	.02	.02	.00	309.
1.01	5.40	68	.01	.01	.00	25.	1.01	18.10	218	.02	.02	.00	188.
1.01	5.45	69	.01	.01	.00	25.	1.01	18.15	219	.02	.02	.00	182.
1.01	5.50	70	.01	.01	.00	25.	1.01	18.20	220	.02	.02	.00	114.
1.01	5.55	71	.01	.01	.00	25.	1.01	18.25	221	.02	.02	.00	81.
1.01	6.00	72	.01	.01	.00	26.	1.01	18.30	222	.02	.02	.00	66.
1.01	6.05	73	.07	.05	.02	41.	1.01	18.35	223	.02	.02	.00	59.
1.01	6.10	74	.07	.05	.02	77.	1.01	18.40	224	.02	.02	.00	55.
1.01	6.15	75	.07	.05	.02	108.	1.01	18.45	225	.02	.02	.00	54.
1.01	6.20	76	.07	.06	.01	124.	1.01	18.50	226	.02	.02	.00	53.
1.01	6.25	77	.07	.06	.01	133.	1.01	18.55	227	.02	.02	.00	53.
1.01	6.30	78	.07	.06	.01	139.	1.01	19.00	228	.02	.02	.00	53.
1.01	6.35	79	.07	.06	.01	142.	1.01	19.05	229	.02	.02	.00	53.
1.01	6.40	80	.07	.06	.01	145.	1.01	19.10	230	.02	.02	.00	53.
1.01	6.45	81	.07	.06	.01	147.	1.01	19.15	231	.02	.02	.00	53.
1.01	6.50	82	.07	.06	.01	149.	1.01	19.20	232	.02	.02	.00	53.
1.01	6.55	83	.07	.06	.01	151.	1.01	19.25	233	.02	.02	.00	53.
1.01	7.00	84	.07	.06	.01	153.	1.01	19.30	234	.02	.02	.00	53.
1.01	7.05	85	.07	.06	.01	154.	1.01	19.35	235	.02	.02	.00	53.
1.01	7.10	86	.07	.06	.01	155.	1.01	19.40	236	.02	.02	.00	53.
1.01	7.15	87	.07	.06	.01	156.	1.01	19.45	237	.02	.02	.00	53.
1.01	7.20	88	.07	.06	.01	157.	1.01	19.50	238	.02	.02	.00	53.
1.01	7.25	89	.07	.06	.01	158.	1.01	19.55	239	.02	.02	.00	53.
1.01	7.30	90	.07	.06	.01	159.	1.01	20.00	240	.02	.02	.00	53.
1.01	7.35	91	.07	.06	.01	160.	1.01	20.05	241	.02	.02	.00	53.
1.01	7.40	92	.07	.06	.01	161.	1.01	20.10	242	.02	.02	.00	53.
1.01	7.45	93	.07	.06	.01	162.	1.01	20.15	243	.02	.02	.00	53.
1.01	7.50	94	.07	.06	.01	162.	1.01	20.20	244	.02	.02	.00	53.
1.01	7.55	95	.07	.06	.00	163.	1.01	20.25	245	.02	.02	.00	533.
1.01	8.00	96	.07	.06	.00	163.	1.01	20.30	246	.02	.02	.00	53.
1.01	8.05	97	.07	.06	.00	164.	1.01	20.35	247	.02	.02	.00	53.
1.01	8.10	98	.07	.06	.00	165.	1.01	20.40	248	.02	.02	.00	53.
1.01	8.15	99	.07	.06	.00	165.	1.01	20.45	249	.02	.02	.00	53.
1.01	8.20	100	.07	.07	.00	166.	1.01	20.50	250	.02	.02	.00	53.
1.01	8.25	101	.07	.07	.00	166.	1.01	20.55	251	.02	.02	.00	53.
1.01	8.30	102	.07	.07	.00	166.	1.01	21.00	252	.02	.02	.00	53.
1.01	8.35	103	.07	.07	.00	167.	1.01	21.05	253	.02	.02	.00	53.
1.01	8.40	104	.07	.07	.00	167.	1.01	21.10	254	.02	.02	.00	53.
1.01	8.45	105	.07	.07	.00	167.	1.01	21.15	255	.02	.02	.00	53.
1.01	8.50	106	.07	.07	.00	168.	1.01	21.20	256	.02	.02	.00	53.
1.01	8.55	107	.07	.07	.00	168.	1.01	21.25	257	.02	.02	.00	53.
1.01	9.00	108	.07	.07	.00	168.	1.01	21.30	258	.02	.02	.00	53.
1.01	9.05	109	.07	.07	.00	169.	1.01	21.35	259	.02	.02	.00	53.
1.01	9.10	110	.07	.07	.00	169.	1.01	21.40	260	.02	.02	.00	53.
1.01	9.15	111	.07	.07	.00	169.	1.01	21.45	261	.02	.02	.00	53.
1.01	9.20	112	.07	.07	.00	169.	1.01	21.50	262	.02	.02	.00	53.
1.01	9.25	113	.07	.07	.00	170.	1.01	21.55	263	.02	.02	.00	53.
1.01	9.30	114	.07	.07	.00	170.	1.01	22.00	264	.02	.02	.00	53.
1.01	9.35	115	.07	.07	.00	170.	1.01	22.05	265	.02	.02	.00	53.

1.01	9.45	116	.07	.07	.00	170.	1.01	22.10	266	.02	.02	.00	53.
1.01	9.45	117	.07	.07	.00	170.	1.01	22.15	267	.02	.02	.00	53.
1.01	9.50	118	.07	.07	.00	171.	1.01	22.20	268	.02	.02	.00	53.
1.01	9.55	119	.07	.07	.00	171.	1.01	22.25	269	.02	.02	.00	53.
1.01	10.00	120	.07	.07	.00	171.	1.01	22.30	270	.02	.02	.00	53.
1.01	10.05	121	.07	.07	.00	171.	1.01	22.35	271	.02	.02	.00	53.
1.01	10.10	122	.07	.07	.00	171.	1.01	22.40	272	.02	.02	.00	53.
1.01	10.15	123	.07	.07	.00	171.	1.01	22.45	273	.02	.02	.00	53.
1.01	10.20	124	.07	.07	.00	172.	1.01	22.50	274	.02	.02	.00	53.
1.01	10.25	125	.07	.07	.00	172.	1.01	22.55	275	.02	.02	.00	53.
1.01	10.30	126	.07	.07	.00	172.	1.01	23.00	276	.02	.02	.00	53.
1.01	10.35	127	.07	.07	.00	172.	1.01	23.05	277	.02	.02	.00	53.
1.01	10.40	128	.07	.07	.00	172.	1.01	23.10	278	.02	.02	.00	53.
1.01	10.45	129	.07	.07	.00	172.	1.01	23.15	279	.02	.02	.00	53.
1.01	10.50	130	.07	.07	.00	172.	1.01	23.20	280	.02	.02	.00	53.
1.01	10.55	131	.07	.07	.00	172.	1.01	23.25	281	.02	.02	.00	53.
1.01	11.00	132	.07	.07	.00	173.	1.01	23.30	282	.02	.02	.00	53.
1.01	11.05	133	.07	.07	.00	173.	1.01	23.35	283	.02	.02	.00	53.
1.01	11.10	134	.07	.07	.00	173.	1.01	23.40	284	.02	.02	.00	53.
1.01	11.15	135	.07	.07	.00	173.	1.01	23.45	285	.02	.02	.00	53.
1.01	11.20	136	.07	.07	.00	173.	1.01	23.50	286	.02	.02	.00	53.
1.01	11.25	137	.07	.07	.00	173.	1.01	23.55	287	.02	.02	.00	53.
1.01	11.30	138	.07	.07	.00	173.	1.02	0.00	288	.02	.02	.00	53.
1.01	11.35	139	.07	.07	.00	173.	1.02	.05	289	0.00	0.00	0.00	46.
1.01	11.40	140	.07	.07	.00	173.	1.02	.10	290	0.00	0.00	0.00	27.
1.01	11.45	141	.07	.07	.00	173.	1.02	.15	291	0.00	0.00	0.00	13.
1.01	11.50	142	.07	.07	.00	173.	1.02	.20	292	0.00	0.00	0.00	6.
1.01	11.55	143	.07	.07	.00	173.	1.02	.25	293	0.00	0.00	0.00	3.
1.01	12.00	144	.07	.07	.00	174.	1.02	.30	294	0.00	0.00	0.00	1.
1.01	12.05	145	.21	.21	.00	222.	1.02	.35	295	0.00	0.00	0.00	1.
1.01	12.10	146	.21	.20	.00	341.	1.02	.40	296	0.00	0.00	0.00	0.
1.01	12.15	147	.21	.20	.00	437.	1.02	.45	297	0.00	0.00	0.00	0.
1.01	12.20	148	.21	.20	.00	482.	1.02	.50	298	0.00	0.00	0.00	0.
1.01	12.25	149	.21	.20	.00	504.	1.02	.55	299	0.00	0.00	0.00	0.
1.01	12.30	150	.21	.20	.00	514.	1.02	1.00	300	0.00	0.00	0.00	0.
									SUM	32.37	31.35	1.02	80078.
										(822.)(	796.)(	26.)(	2267.33)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4163.	874.	278.	267.	80073.
CMS	118.	25.	8.	8.	2267.
INCHES		.84	1.63	31.35	31.35
MM		20.58	41.38	796.27	796.27
ACRE-FT		433.	551.	551.	551.
THOUS CU M		534.	680.	680.	680.

HYDROGRAPH AT STA 1590 FOR PLAN 1, RATIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	1.	2.	2.	3.	4.	5.	6.	7.
8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.
36.	37.	38.	39.	40.	41.	42.	43.	44.	45.	46.	47.	48.	49.
50.	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.	62.	63.
64.	65.	66.	67.	68.	69.	70.	71.	72.	73.	74.	75.	76.	77.
78.	79.	80.	81.	82.	83.	84.	85.	86.	87.	88.	89.	90.	91.
92.	93.	94.	95.	96.	97.	98.	99.	100.	101.	102.	103.	104.	105.
106.	107.	108.	109.	110.	111.	112.	113.	114.	115.	116.	117.	118.	119.
120.	121.	122.	123.	124.	125.	126.	127.	128.	129.	130.	131.	132.	133.
134.	135.	136.	137.	138.	139.	140.	141.	142.	143.	144.	145.	146.	147.
148.	149.	150.	151.	152.	153.	154.	155.	156.	157.	158.	159.	160.	161.
162.	163.	164.	165.	166.	167.	168.	169.	170.	171.	172.	173.	174.	175.

166.	166.	167.	167.	167.	168.	168.	168.	169.	169.
169.	169.	170.	170.	170.	170.	170.	171.	171.	171.
171.	171.	171.	172.	172.	172.	172.	172.	172.	172.
172.	173.	173.	173.	173.	173.	173.	173.	173.	173.
173.	173.	173.	174.	222.	341.	48[illegible].	482.	504.	514.
519.	522.	523.	524.	524.	525.	540.	578.	605.	619.
625.	629.	630.	631.	632.	632.	632.	638.	659.	669.
753.	773.	783.	788.	790.	791.	792.	792.	792.	792.
749.	710.	789.	950.	1191.	1763.	3096.	4163.	3696.	2703.
2067.	1512.	1192.	980.	854.	792.	761.	749.	744.	742.
742.	741.	741.	741.	719.	665.	621.	601.	591.	588.
584.	583.	583.	583.	583.	583.	509.	325.	182.	114.
81.	66.	59.	55.	54.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	58.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	46.	27.
13.	6.	3.	1.	1.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4163.	974.	279.	267.	60073.
CMS	118.	28.	8.	8.	2367.
INCHES		24.63	31.35	31.35	31.35
MM		625.52	796.27	796.27	796.27
AC-FT		438.	551.	551.	551.
THOUS CU M		534.	680.	680.	680.

HYDROGRAPH AT STA011598 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	2.	2.	3.
3.	3.	4.	4.	5.	5.	5.	6.	6.	6.
7.	7.	7.	7.	8.	8.	8.	8.	8.	9.
9.	9.	9.	9.	10.	10.	10.	10.	10.	10.
11.	11.	11.	11.	11.	11.	11.	11.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	13.	13.
13.	13.	20.	39.	54.	62.	67.	69.	71.	73.
74.	75.	76.	76.	77.	78.	78.	79.	79.	80.
80.	80.	81.	81.	81.	82.	82.	82.	83.	83.
83.	83.	83.	84.	84.	84.	84.	84.	84.	84.
85.	85.	85.	85.	85.	85.	85.	85.	85.	85.
86.	86.	86.	86.	86.	86.	86.	86.	86.	86.
86.	86.	86.	86.	86.	86.	86.	87.	87.	87.
87.	87.	87.	87.	111.	171.	219.	241.	252.	257.
261.	261.	262.	262.	262.	262.	270.	288.	302.	309.
313.	314.	315.	316.	316.	316.	316.	318.	327.	354.
378.	391.	391.	394.	395.	396.	396.	396.	396.	396.
396.	355.	395.	395.	595.	882.	1548.	2044.	1682.	1382.
1148.	756.	596.	498.	427.	396.	381.	375.	370.	371.
371.	371.	371.	369.	338.	311.	300.	300.	300.	300.
292.	292.	291.	291.	291.	291.	254.	168.	91.	91.
91.	89.	89.	88.	87.	86.	86.	28.	86.	86.
86.	86.	86.	86.	86.	86.	86.	86.	86.	86.
86.	86.	86.	86.	86.	86.	86.	86.	86.	86.
86.	86.	86.	86.	86.	86.	86.	86.	86.	86.
86.	86.	86.	86.	86.	86.	86.	86.	86.	86.
86.	86.	86.	86.	86.	86.	86.	86.	86.	86.

PMF AND ONE-HALF PMF ROUTING

26.	26.	26.	26.	26.	26.	26.	26.	23.	19.
6.	3.	1.	1.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2082.	437.	139.	133.	40036.
CMS	59.	12.	4.	4.	1134.
INCHES		12.31	15.67	15.67	15.67
MM		312.76	398.14	398.14	398.14
AC-FT		217.	276.	276.	276.
THOUS CU M		267.	340.	340.	340.

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH SHADY LAKE DAM (MO 11598)

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
011598	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	ISK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-710.	-1

STAGE	709.75	710.00	711.00	711.50	712.00	712.75	713.10	713.56	714.91	716.17
	714.39	714.59	714.77	714.94	715.10	715.26	715.41	716.08	716.69	717.24
FLOW	0.00	6.00	65.00	101.00	115.00	133.00	150.00	199.00	266.00	314.00
	387.00	479.00	592.00	721.00	869.00	1038.00	1222.00	2302.00	3585.00	4838.00
SURFACE AREA=	0.	1.	56.	64.	84.	104.	154.			
CAPACITY=	0.	8.	256.	384.	596.	860.	1314.			
ELEVATION=	698.	700.	709.	710.	713.	719.	720.			

CREL	SPWID	COOL	EXPL	CLEVL	COOL	CAREA	EXPL
709.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
714.0	0.0	0.0	0.

STATION 011598, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

18.	18.	19.	19.	20.	20.	20.	21.	21.	21.
21.	22.	22.	23.	30.	35.	41.	48.	54.	59.
69.	71.	77.	82.	87.	92.	97.	101.	103.	104.
106.	107.	109.	110.	111.	113.	114.	115.	116.	118.
119.	120.	121.	122.	123.	124.	125.	125.	126.	127.
128.	129.	130.	131.	131.	132.	133.	135.	136.	137.
139.	140.	141.	143.	144.	145.	146.	147.	148.	149.
150.	151.	153.	155.	156.	158.	159.	160.	161.	162.
163.	164.	165.	165.	168.	177.	194.	223.	254.	291.
329.	369.	406.	439.	462.	479.	488.	519.	544.	567.
586.	602.	613.	620.	625.	628.	629.	631.	636.	654.
686.	717.	745.	769.	775.	782.	787.	789.	791.	791.
782.	757.	754.	809.	939.	1239.	2044.	3214.	3774.	3322.
2348.	1997.	1560.	1236.	1051.	932.	855.	807.	779.	762.
753.	747.	745.	741.	737.	717.	697.	656.	632.	614.
603.	595.	590.	588.	586.	585.	571.	517.	456.	364.
309.	274.	246.	224.	204.	191.	180.	169.	160.	151.
147.	143.	139.	136.	133.	131.	129.	128.	126.	125.
123.	122.	120.	119.	117.	116.	114.	113.	111.	110.
108.	107.	105.	104.	102.	101.	98.	94.	91.	89.
86.	84.	81.	79.	77.	76.	74.	72.	71.	70.
69.	67.	66.	65.	64.	64.	63.	62.	62.	61.
61.	60.	60.	59.	59.	59.	58.	58.	57.	56.
54.	51.	48.	45.	42.	39.	37.	34.	32.	30.

STORAGE

29.	29.	29.	29.	29.	29.	29.	29.	29.	29.
29.	29.	29.	29.	29.	29.	29.	29.	29.	29.
29.	29.	29.	29.	29.	29.	29.	29.	29.	29.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	31.	31.	31.	31.	31.	31.
31.	31.	31.	31.	31.	31.	31.	31.	31.	31.
31.	31.	31.	31.	31.	32.	32.	32.	32.	32.
32.	32.	32.	32.	32.	33.	34.	34.	35.	36.
36.	37.	37.	38.	38.	39.	39.	39.	40.	40.
41.	41.	41.	42.	42.	42.	43.	43.	43.	44.
44.	44.	45.	45.	45.	46.	46.	46.	46.	47.
47.	47.	48.	48.	48.	48.	49.	49.	49.	49.
50.	50.	50.	50.	50.	51.	51.	51.	51.	51.
51.	52.	52.	52.	52.	52.	52.	52.	52.	52.
53.	53.	53.	53.	53.	54.	55.	57.	59.	60.
62.	63.	64.	64.	65.	65.	66.	66.	66.	67.
67.	67.	67.	67.	68.	68.	68.	68.	68.	68.
68.	68.	69.	69.	69.	70.	70.	70.	70.	70.
70.	69.	69.	70.	71.	74.	79.	86.	89.	87.
83.	79.	76.	74.	72.	71.	70.	70.	69.	69.
69.	69.	69.	69.	69.	69.	68.	68.	68.	67.
67.	67.	67.	67.	67.	67.	67.	66.	66.	66.
65.	64.	58.	57.	56.	55.	54.	53.	52.	50.
49.	49.	50.	49.	49.	48.	47.	47.	46.	46.
45.	45.	45.	44.	44.	43.	43.	42.	42.	42.
41.	41.	40.	40.	40.	39.	39.	39.	39.	38.
38.	38.	38.	37.	37.	37.	37.	37.	37.	37.
36.	36.	36.	36.	35.	35.	36.	36.	36.	36.
36.	36.	36.	36.	35.	35.	36.	35.	35.	35.
34.	34.	34.	34.	34.	33.	33.	33.	33.	33.

STAGE

789.8	789.8	789.8	789.8	789.8	789.8	789.8	789.8	789.8	789.8
789.8	789.8	789.8	789.8	789.8	789.8	789.8	789.8	789.8	789.8

709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.9	709.9
709.9	709.9	709.9	709.9	709.9	709.9	710.0	710.0	710.0	710.0
710.0	710.0	710.0	710.1	710.1	710.1	710.1	710.1	710.1	710.1
710.1	710.1	710.1	710.2	710.2	710.2	710.2	710.2	710.2	710.2
710.2	710.2	710.2	710.2	710.2	710.2	710.2	710.2	710.3	710.3
710.3	710.3	710.3	710.3	710.4	710.5	710.6	710.7	710.8	710.9
711.0	711.1	711.2	711.2	711.3	711.4	711.4	711.5	711.6	711.6
711.7	711.7	711.8	711.8	711.9	711.9	712.0	712.0	712.1	712.1
712.1	712.2	712.2	712.3	712.3	712.4	712.4	712.4	712.5	712.5
712.5	712.6	712.6	712.7	712.7	712.7	712.8	712.8	712.8	712.8
712.9	712.9	712.9	712.9	713.0	713.0	713.0	713.0	713.1	713.1
713.1	713.1	713.1	713.1	713.2	713.2	713.2	713.2	713.2	713.2
713.2	713.2	713.2	713.2	713.3	713.4	713.5	713.7	713.9	714.1
714.2	714.3	714.4	714.5	714.6	714.6	714.6	714.7	714.7	714.7
714.8	714.8	714.8	714.8	714.8	714.8	714.8	714.8	714.8	714.9
714.9	714.9	715.0	715.0	715.0	715.0	715.0	715.0	715.0	715.0
715.0	715.0	715.0	715.0	715.2	715.4	715.9	716.5	716.8	716.6
716.2	715.9	715.6	715.4	715.3	715.2	715.1	715.0	715.0	715.0
715.0	715.0	715.0	715.0	715.0	714.9	714.9	714.9	714.9	714.9
714.8	714.8	714.8	714.8	714.8	714.8	714.7	714.7	714.5	714.5
714.1	714.0	713.8	713.7	713.6	713.5	713.4	713.3	713.2	713.1
713.0	713.0	712.9	712.8	712.7	712.7	712.6	712.5	712.5	712.4
712.3	712.3	712.2	712.2	712.1	712.0	712.0	711.9	711.9	711.8
711.8	711.7	711.6	711.6	711.5	711.5	711.5	711.4	711.4	711.3
711.3	711.3	711.2	711.2	711.2	711.1	711.1	711.1	711.1	711.1
711.0	711.0	711.0	711.0	711.0	711.0	711.0	711.0	710.9	710.9
710.9	710.9	710.9	710.9	710.9	710.9	710.9	710.9	710.9	710.8
710.8	710.8	710.7	710.7	710.6	710.6	710.5	710.5	710.4	710.4

PEAK OUTFLOW IS 3774. AT TIME 15.75 HOURS.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3774.	857.	276.	265.	79532.
CMS	107.	24.	8.	8.	2252.
INCHES		24.17	31.14	31.14	31.14
MM		613.82	790.89	790.89	790.89
AC-FT		425.	548.	549.	549.
THOUS CU M		524.	676.	676.	676.

STATION 01598, PLAN 16, RATIO 8

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
4.	4.	4.	4.	4.	4.	4.	4.	5.	5.
5.	5.	6.	6.	6.	6.	6.	6.	7.	7.
8.	8.	8.	8.	9.	9.	9.	9.	10.	10.
12.	12.	13.	14.	15.	17.	21.	24.	27.	30.
33.	36.	39.	43.	46.	47.	49.	51.	53.	55.
57.	59.	61.	63.	64.	65.	66.	67.	68.	69.
69.	70.	71.	72.	73.	74.	75.	76.	76.	76.
77.	78.	78.	79.	79.	80.	80.	81.	81.	82.
82.	82.	82.	82.	83.	83.	83.			

84.	84.	84.	84.	84.	85.	85.	85.	85.	85.
85.	85.	85.	85.	86.	90.	98.	103.	107.	111.
115.	118.	121.	124.	127.	150.	153.	139.	145.	165.
166.	178.	189.	199.	213.	225.	235.	245.	253.	266.
281.	296.	309.	325.	340.	351.	360.	368.	373.	378.
380.	377.	376.	389.	423.	525.	609.	1391.	1778.	1657.
1330.	1054.	858.	710.	607.	536.	483.	453.	431.	415.
403.	394.	388.	384.	380.	373.	363.	351.	340.	330.
323.	316.	312.	309.	306.	304.	302.	286.	862.	289.
217.	197.	184.	171.	160.	149.	144.	140.	135.	132.
130.	128.	126.	123.	121.	119.	117.	115.	113.	110.
108.	106.	104.	102.	97.	93.	89.	83.	79.	75.
72.	68.	65.	63.	61.	58.	56.	54.	53.	51.
49.	48.	47.	45.	44.	43.	42.	41.	40.	39.
38.	37.	37.	36.	35.	35.	34.	34.	33.	33.
32.	32.	32.	31.	31.	31.	30.	30.	30.	29.
28.	28.	25.	23.	21.	20.	19.	17.	16.	15.

STORAGE

29.	29.	29.	29.	29.	29.	29.	29.	29.	29.
29.	29.	29.	29.	29.	29.	29.	29.	29.	29.
29.	29.	29.	29.	29.	29.	29.	29.	29.	29.
29.	29.	29.	29.	29.	29.	29.	29.	29.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
30.	30.	30.	30.	30.	30.	30.	30.	31.	31.
31.	31.	31.	31.	31.	31.	32.	32.	32.	32.
33.	33.	33.	34.	34.	34.	34.	34.	35.	35.
35.	35.	35.	35.	36.	36.	36.	36.	36.	36.
36.	36.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	38.
38.	38.	38.	38.	38.	38.	38.	38.	38.	38.
38.	38.	38.	38.	38.	38.	38.	38.	38.	38.
38.	38.	38.	38.	38.	38.	39.	40.	41.	42.
43.	44.	45.	46.	47.	48.	49.	50.	51.	52.
53.	54.	55.	56.	56.	57.	58.	58.	59.	59.
60.	60.	61.	62.	62.	62.	63.	63.	63.	63.
63.	63.	63.	63.	64.	66.	70.	73.	77.	77.
78.	78.	70.	69.	67.	66.	65.	65.	69.	69.
68.	68.	63.	63.	63.	63.	63.	62.	62.	62.
61.	61.	61.	61.	61.	61.	61.	60.	59.	58.
57.	55.	54.	53.	52.	51.	51.	50.	49.	48.
47.	47.	46.	45.	45.	44.	44.	43.	42.	42.
41.	41.	40.	40.	39.	39.	38.	38.	37.	37.
37.	36.	36.	36.	35.	35.	35.	35.	35.	35.
34.	34.	34.	34.	34.	34.	34.	34.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	32.
32.	32.	32.	32.	32.	32.	32.	31.	31.	31.

TABC

709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8
709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8
709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.8
709.8	709.8	709.8	709.8	709.8	709.8	709.8	709.9	709.9	709.9
709.9	709.9	709.9	709.9	709.9	709.9	709.9	709.9	709.9	709.9
710.0	710.0	710.0	710.0	710.0	710.0	710.0	710.0	710.0	710.0
710.0	710.0	710.0	710.0	710.0	710.0	710.0	710.1	710.1	710.1
710.1	710.1	710.1	710.1	710.1	710.1	710.1	710.1	710.1	710.1
710.1	710.1	710.1	710.1	710.1	710.1	710.1	710.1	710.1	710.1

710.8	710.9	710.9	710.9	710.9	710.9	711.0	711.0	711.0	711.0
711.0	711.1	711.1	711.1	711.1	711.1	711.1	711.1	711.1	711.2
711.2	711.2	711.2	711.2	711.2	711.2	711.2	711.2	711.2	711.2
711.2	711.2	711.2	711.2	711.2	711.2	711.2	711.3	711.3	711.3
711.3	711.3	711.3	711.3	711.3	711.3	711.3	711.3	711.3	711.3
711.3	711.3	711.3	711.3	711.3	711.4	711.5	711.6	711.7	711.9
712.0	712.1	712.3	712.4	712.5	712.6	712.8	712.9	713.0	713.1
713.3	713.4	713.5	713.6	713.6	713.7	713.8	713.8	713.9	714.0
714.0	714.1	714.1	714.2	714.2	714.3	714.3	714.3	714.3	714.4
714.4	714.4	714.4	714.4	714.5	714.7	715.0	715.5	715.8	715.7
715.5	715.3	715.1	714.9	714.8	714.7	714.6	714.5	714.5	714.5
714.4	714.4	714.4	714.4	714.4	714.3	714.3	714.3	714.2	714.2
714.2	714.2	714.2	714.1	714.1	714.1	714.1	714.0	713.9	713.8
713.7	713.5	713.4	713.3	713.2	713.1	713.0	712.9	712.8	712.7
712.6	712.5	712.4	712.3	712.3	712.2	712.1	712.0	711.9	711.8
711.8	711.7	711.6	711.5	711.5	711.4	711.3	711.3	711.2	711.1
711.1	711.0	711.0	711.0	710.9	710.9	710.9	710.8	710.8	710.8
710.7	710.7	710.7	710.7	710.6	710.6	710.6	710.6	710.6	710.6
710.5	710.5	710.5	710.5	710.5	710.5	710.5	710.5	710.5	710.5
710.4	710.4	710.4	710.4	710.4	710.4	710.4	710.4	710.4	710.4
710.4	710.3	710.3	710.3	710.3	710.2	710.2	710.2	710.2	710.2

PEAK OUTFLOW IS 1778. AT TIME 15.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1778.	405.	138.	132.	39724.
CMS	50.	11.	4.	4.	1125.
INCHES		11.40	15.55	15.55	15.55
MM		289.67	395.03	395.03	395.03
AC-FT		201.	274.	274.	274.
THOUS CU M		247.	337.	337.	337.

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SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	011598	.33	1	8163.	2082.
		(.85)		(117.89)(	58.95)(
ROUTED TO	011598	.33	1	3774.	1779.
		(.85)		(106.71)(	50.36)(

AD-A106 624 PRC CONSOER TOWNSEND INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. SHADY LAKE DAM (MO 11598), MISSOUR--ETC(U)
SEP 80 W G SHIFRIN DACW43-80-C-0094

UNCLASSIFIED NL

END
DATE FILMED
12-81
DTIC

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	705.75	709.75	714.00
STORAGE	29.	29.	60.
OUTFLOW	0.	0.	276.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	716.79	2.79	39.	3774.	6.00	15.75	0.00
.50	715.76	1.76	77.	1778.	4.00	13.75	0.00

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 011598
ROUTE HYDROGRAPH TO 011598
END OF NETWORK

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79

RUN DATE= 80/07/21.
TIME= 08.33.42.

DAM SAFETY INSPECTION-MISSOURI
SHADY LAKE DAM (MO 11598)
PERCENT PMF

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	ITRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .15 .17 .18 .20

SUB-AREA RUNOFF COMPUTATION

INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMETERS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
011598	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	AREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.38	0.00	.93	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.00	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRTL	CNSTL	RTIOL	ERAIN	STRKS	RTIOR	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-92.00	0.00	0.00

CURVE NO = 92.00 (METNESS = -1.00) EFFECT CN = 92.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .14

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

HOUR	MIN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HOUR	MIN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 32.37 31.35 1.02 88070.
(822.3)(796.6)(25.8)(2267.33)

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH SHADY LAKE DAM (NO 115961

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
011598	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	CLOSS	AVG	IRES	ISAME	ICPT	IPMP	LSTR
0.0	0.0000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-710.	-1

STAGE	709.75	710.00	711.00	711.50	712.00	712.75	713.10	713.56	713.91	714.17
	714.39	714.59	714.77	714.94	715.10	715.26	715.41	716.08	716.69	717.24
FLOW	0.00	0.00	65.00	101.00	115.00	133.00	140.00	199.00	256.00	314.00
	387.00	479.00	592.00	721.00	869.00	1038.00	1232.00	2302.00	3535.00	4826.00

SURFACE AREA=	0.	1.	5.	6.	8.	10.	15.
CAPACITY=	0.	2.	25.	30.	49.	80.	131.
ELEVATION=	691.	700.	709.	710.	713.	714.	720.

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
709.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
714.0	0.0	4.0	0.

PEAK OUTFLOW IS 1721. AT TIME 16.00 HOURS

PEAK OUTFLOW IS 2156. AT TIME 16.00 HOURS

PEAK OUTFLOW IS 858. AT TIME 16.00 HOURS

PEAK OUTFLOW IS 306. AT TIME 16.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS			
				RATIO 1 .15	RATIO 2 .17	RATIO 3 .18	RATIO 4 .20
HYDROGRAPH AT	011995	.33	1	624.	708.	749.	835.
	(	.85)	(	17.68)(	20.04)(	21.22)(	23.58)(
ROUTED TO	011596	.33	1	172.	216.	242.	306.
	(	.85)	(	4.87)(	6.12)(	6.86)(	8.67)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	703.75	709.75	714.00
STORAGE	29.	29.	60.
OUTFLOW	0.	0.	276.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	713.31	0.00	53.	172.	0.00	16.08	0.00
.17	713.67	0.00	56.	216.	0.00	16.08	0.00
.18	713.93	0.00	58.	242.	0.00	16.08	0.00
.20	714.13	.13	61.	306.	.33	16.08	0.00

HEC-2 INPUT AND SUMMARY TABLE

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*****************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED JULY 1979
  ERROR CORR -  01.0 .03
  MODIFICATION -  50.51.52.53
*****************************************************

T1        DAM SAFETY INSPECTION / MISSOURI-1930
T2        SHADY LAKE DAM (MO.1159 )
T3        EMERGENCY SPILLWAY RATING CURVE

J1  ICHECK    INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

      -1.        2.        0.        1.  -1.000.00     0.00      0.0       0.    713.000     0.000

J2  NPROF     IPLOT     PRFVS     XSECV     XSECH     FN        ALLOC     IBW       CHNIM     ITRACE

      1.000     0.000    -1.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38.000     4.000    25.000     4.000    [illegible]    10.000    40.000     3.000     5.000    17.000

J5  LPRNT     NUMSEC                  ********REQUESTED SECTION NUMBERS********

    -10.000   -10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
 JC      .030      .030      .030      .0[illegible]      .300      0.000     0.000     0.000     0.000     0.000
 QT    14.000    10.000    50.000   100.000   150.000   200.000   250.000   300.000   350.000   400.000
 GT   450.000   500.000   750.000  1000.000  1250.000  1500.000     0.000     0.000     0.000     0.000

 X1     1.000     4.000     0.000    51.000     0.000     0.000     0.000     0.000     0.000     0.000
 SR   714.000     0.000   712.750    14.000   712.750    41.000   714.000    31.000     0.000     0.000

 X1     2.000     0.000     0.000     0.000    25.000    25.000    25.000     0.000     0.000     0.000
 EJ     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
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**********************************************
  HEC2 RELEASE DATED NOV 76 UPDATED JULY 1977
  ERROR CORR - 01.02.03
  MODIFICATION - 50.51.52.53
**********************************************

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

EMERGENCY SPILLWAY RATE

SUMMARY PRINTOUT

      SECNO      DEPTH      AREA      TOPWID      VCH       -V          .          FS       10KAS     K*XNCH
  *   1.000       .16       4.52      30.34       .31       .01       16.00     712.96     207.98      30.00
  *   1.600       .45       15.99     35.58       3.57      .20       50.00     713.40     181.26      30.00
  *   1.800       .69       25.13     41.21       4.33      .23      100.00     713.73     159.64      30.00
  *   1.900       .88       31.16     43.83       4.81      .26      150.00     713.98     149.49      30.00
  *   1.960      1.05       36.79     47.10       5.16      .41      200.00     714.21     143.77      30.00
  *   1.980      1.19       45.91     49.85       5.45      .45      250.00     714.40     135.57      30.00
  *   1.990      1.31       51.91     51.00       5.78      .52      300.00     714.56     133.86      30.00
  *   1.996      1.40       57.64     51.00       6.09      .57      350.00     714.70     129.97      30.00
  *   1.998      1.53       68.82     51.00       6.35      .63      400.00     714.91     126.10      30.00
  *   1.999      1.63       77.07     51.00       6.61      .68      450.00     715.06     124.06      30.00
  *   1.999      1.73       79.95     51.00       6.84      .72      500.00     715.20     121.62      30.00
  *   1.999      2.15       96.13     51.00       7.80      .95      750.00     715.87     112.13      30.00
  *   1.999      2.56      116.99     51.00       8.59     1.15     1000.00     716.47     107.35      30.00
  *   1.999      2.94      134.71     51.00       9.28     1.34     1250.00     717.02     105.02      30.00

      2.000       .14       10.37     33.54       .96       .01       10.00     713.16      10.16      30.00
      2.000       .75       35.51     41.34      1.96       .06       50.00     713.56      22.86      30.00
      2.000      1.08       49.21     47.27      2.55       .10      100.00     713.91      34.11      30.00
      2.000      1.25       57.69     51.00      2.96       .14      150.00     714.17      36.19      30.00
      2.000      1.37       63.14     51.00      3.33       .17      200.00     714.39      35.73      30.00
      2.000      1.63       68.36     51.00      3.66       .21      250.00     714.59      37.76      30.00
      2.000      1.78       79.84     51.00      3.96       .24      300.00     714.77      38.75      30.00
      2.000      1.91       86.82     51.00      4.23       .28      350.00     714.94      39.60      30.00
      2.000      2.04       89.46     51.00      4447       .31      400.00     715.10      40.39      30.00
      2.000      2.16       95.10     51.00      4.73       .33      450.00     715.26      41.71      30.00
      2.000      2.28      101.06     51.00      4.99       .38      500.00     715.41      42.41      30.00
      2.000      2.88      127.43     51.00      6.09       .54      750.00     716.08      45.18      30.00
      2.000      3.28      145.84     51.00      6.64       .64     1000.00     716.69      47.12      30.00
      2.000      3.64      161.71     51.00      7.24       .81     1250.00     717.84      47.55      30.00

SUMMARY OF ERRORS

CAUTION  SECNO=  1.000  PROFILE #  1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=  1.600  PROFILE #  1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=  1.800  PROFILE #  1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=  1.900  PROFILE #  1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=  1.960  PROFILE #  1  CRITICAL DEPTH ASSUMED
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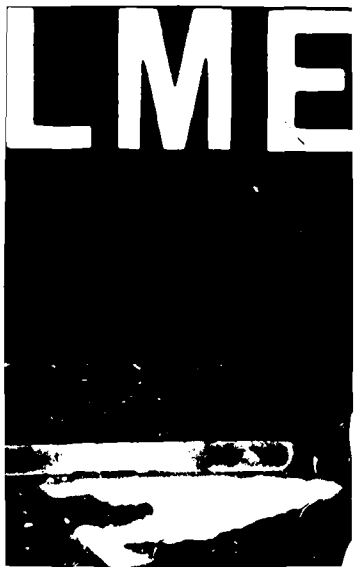
LME